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SAMPLING AND ANALYSIS PLAN

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EXECUTIVE SUMMARY

As part of the environmental management program for the refinery, HOVIC operates two Resource Conservation and Recovery Act (RCRA) land treatment units (landfarms) and three wastewater treatment impoundments (lagoons). One other landfarm, operated before the issuance of this document, has been RCRA closed. The RCRA regulations given in **Subpart M - Land Treatment Unsaturated Zone Monitoring of 40 CFR 264.278**, **Subpart F - Ground Water Protection of 40 CFR 265.90 through 265.94 (Interim Status requirements)** and in **40 CFR 264.90 through 264.100 (Part B Permit requirements)** require the owner and/or operator of a surface impoundment or land treatment unit to determine the impact of the unit on the quality of groundwater in the uppermost aquifer. Unsaturated zone monitoring (soil and soil-pore liquid) is required for the management of a land treatment unit to determine whether migration of hazardous constituents is occurring from the treatment zone.

This manual provides procedures and specifications for sampling of monitoring wells placed around the RCRA regulated units, sampling of soils beneath the landfarms, and sampling of the unsaturated zone liquids at the Landfarms. This document provides guidance consistent with the best available technologies and presents in detail the essential components of a ground water monitoring and sampling plan in accordance with published guidance acceptable to the U.S. Environmental Protection Agency (EPA).

This sampling and analysis manual was originally prepared in December 1988 and revised in October, 1992. This plan has been revised to include the most recent RCRA Ground-Water Monitoring: Draft Technical Guidance document (EPA/530-R-93-001).

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1.0 INTRODUCTION

As part of the environmental management program for the refinery, HOVIC operates two Resource Conservation and Recovery Act (RCRA) land treatment units (landfarms) and three wastewater treatment impoundments (lagoons). One other landfarm, operated before the issuance of this document, has been RCRA closed.

Oily waste sludges from refinery operations including the wastewater treatment system, storage tank cleanouts, and process areas are treated in the landfarms. Process wastewater is treated in 3 surface impoundment treatment units (Lagoons 1, 2 and 3). Since several of the wastes produced at HOVIC are included as listed or characteristic RCRA wastes, the units treating the wastes must be managed in accordance with the RCRA Part B Permit requirements.

HOVIC originally submitted the RCRA Part B Permit application for landfarm operations in December 1983 and has been working with the United States Environmental Protection Agency (EPA), Region II, in order to meet the evolving RCRA regulatory requirements. The Part B Permit for the Landfarm II and III operations had an effective date of January 9, 1989. A Closure Permit for Landfarm I was issued in December 1990. A Class 2 and Class 3 RCRA Part B Permit Modification Request was submitted by HOVIC on March 25, 1991 to operate the Lagoons.

This manual provides procedures and specifications for sampling of monitoring wells placed around RCRA regulated units, sampling of soils beneath the landfarms, and sampling of the unsaturated zone liquids at the Landfarms.

1.1 SAMPLING PLAN HISTORY

HOVIC has been monitoring the ground water at the facility since 1982 as part of the Landfarm management program. Unsaturated zone monitoring of the landfarms has been conducted at HOVIC since 1988. This sampling and analysis plan was originally prepared in December 1988 and revised in October, 1992. The RCRA Part B Permit renewal and recent developments and improvements in sampling equipment and methodologies advocated a revised monitoring program and a revised sampling and analysis plan. This plan has been revised to include the most recent RCRA Ground-Water Monitoring: Draft Technical Guidance document (EPA/530-R-93-001).

1.2 REGULATORY REQUIREMENTS

Performance standards have been established for ground water monitoring systems at permitted facilities under Subpart M - Land Treatment Unsaturated Zone Monitoring of 40 CFR 264.278, Subpart F - Ground Water Protection of 40 CFR 265.90 through 265.94 (Interim Status requirements) and in 40 CFR 264.90 through 264.100 (Part B Permit requirements).

Pursuant to these requirements, HOVIC must implement a RCRA Detection Monitoring Program Sampling and Analysis Plan capable of determining the impact of the facility on the quality of

the groundwater in the uppermost aquifer below the landfarms and lagoons and on the quality of the below treatment zone soils and soil-pore liquids underlying the operating Landfarms. The Closure Permit for Landfarm I stipulates the conditions for monitoring the uppermost aquifer to assure successful closure of the unit has occurred. The monitoring program must be capable of yielding representative samples for analysis from sources located up- and down-gradient of the waste management areas. The facility should develop and follow a sampling and analysis plan to ensure the quality of the data collected.

1.3 RCRA FACILITY DESCRIPTIONS

Landfarms I, II and III are constructed largely of hydraulically-placed fill material from local dredging operations. Natural settlement was used to compact the soil materials. The Lagoons are lined with fine textured soil originally emplaced by fill activities during facility construction and consist of sediments dredged from the adjacent turning basins. The fill material immediately beneath Lagoons 1 and 2 is comprised of 10 to 15 feet of soil. This material consists of silts, fine sands, and clays. The fill material immediately beneath Lagoon 3 is comprised of 10 feet or more of soil classified as sand-clay mixtures. The base of the existing soil liner system for Lagoon 3 is 15 feet below the existing surface elevation of +30 feet, and 12 feet below the existing surface elevation of +14 feet at Lagoons 1 and 2.

Landfarm I was closed according to an EPA approved closure plan on March 1, 1991. This Landfarm encompassed approximately 1.1 acres and has had an estimated 1,300 tons of non-hazardous and hazardous waste placed in it over its useful lifetime. This landfarm had been used to treat wastes such as leaded tank bottoms (K052), tetraethyl lead (analytical laboratory testing quantities (P110)), slop oil emulsion solids (K049) and heat exchanger bundle solids (K050). Landfarm I is located in the southwest corner of the facility southwest of Lagoon No. 2 (Figure 1).

Landfarm II consists of six individual bays that are used on a rotational basis. The bays have a total surface area of about 12.3 acres. The bays are sloped toward the north. A valved drain pipe at the north end of each bay allows controlled drainage of surface water to API Separator #3. Landfarm II is located in the southeastern section of the refinery just south of Lagoon No. 3.

Landfarm III is divided into multiple bays with a total surface area of approximately 11.8 acres. The bays are sloped to direct the flow of surface water toward a valved system that channels the run-off into a sewer conveyance that culminates into API Separator #3. Landfarm III is located in the southeastern most corner of the facility south of Tank Field 59 and east of the docks.

The three Lagoons are part of the TPDES-permitted wastewater treatment facility (WWTF) for HOVIC process wastewaters. The aerated Lagoons receive the effluent from the IAF units and discharge to canals that eventually transfer the treated wastewater to Outfall 001. Lagoons 1 and 2 are interchangeable and are designed to treat wastewaters from the West Refinery. Lagoon 3 operates continuously and treats wastewater generated from the East Refinery. Lagoons No. 1 and 2 are located to the northeast of Landfarm I and West of Lagoon No. 3. Lagoon No. 3 is located just north of Landfarm II.

The RCRA units are clustered into four groups. Group #1 contains Lagoon 1 and Lagoon 2. Group #2 contains Lagoon 3 and Landfarm 2. Landfarm 1 and Landfarm 3 are separate groupings.

1.4 DESCRIPTION OF MONITORING PROGRAM

1.4.1 Groundwater

Groundwater monitoring is accomplished by collecting groundwater samples from existing monitoring wells located around the RCRA units. The monitoring wells associated with the RCRA waste management units are depicted on Figures 2, 3, 4, and 5. Existing well construction specifications and specifications for the installation of additional wells, if necessary, are included in Appendix A.

Wells LE5A, NSF2, NSF3, and NSF5 shall be sampled to evaluate the groundwater proximal to Group East (Figure 4). Well LE5A is designated as the background well for Group East. Wells LW1, LW3, LW4, LW5, and LW6 shall be sampled to evaluate the groundwater proximal to Group West (Figure 3). Well LW1 is designated as the background well for Group West. Wells BG2, SSF2, SSF4, and SSF5 shall be sampled to evaluate the groundwater proximal to Landfarm III (Figure 5). Well BG2 is designated as the background well for Landfarm III. Wells TEL1, TEL2, TEL3, TEL4, TEL5, TEL6, TEL7, and TEL8 shall be sampled to evaluate the groundwater proximal to Landfarm 1 (Figure 2). Well TEL8 is designated as the background well for Landfarm 1.

1.4.2 Unsaturated Zone

Unsaturated zone monitoring is accomplished by the collection and analysis of soil-pore liquids and soil cores. Glass-block lysimeters are used for the collection of soil-pore liquids. Soil boring equipment is used for the collection of soil cores.

Locations of Lysimeters

Four lysimeters have been emplaced in Landfarm II. Lysimeter 13 is located in the middle of Bay 1; Lysimeter 14 is located in the northwest end of Bay 2; Lysimeter 15 is located in the southwest end of Bay 3; and Lysimeter 16 is located roughly in the middle of Bay 5. The locations of the lysimeters are presented in Figure 4. Four lysimeters have been emplaced in Landfarm III. Lysimeter 17 is located in the southeast corner of Bay 10; Lysimeter 18 is located approximately in the middle of Bay 11; Lysimeter 19 is located roughly in the southwest corner of Bay 7a; and Lysimeter 20 is located in the northwest corner of Bay 5. The locations of these lysimeters are presented in Figure 5.

Background Lysimeters 11 and 12 are emplaced in untreated soils in the unsaturated zone. The locations of the background lysimeters are presented in Figures 4 and 5.

Locations of Soil Samples

Seven soil samples are collected from locations within the bays of Landfarm II and seven soil samples are collected from location within the bays of Landfarm III. The locations of the samples are determined using a random selection process. The procedures for the selection of soil sampling sites are presented in Section 7.1.

1.4.3 Sampling Frequency

The RCRA wells at HOVIC should be sampled at the following frequencies:

- Group #1: Semiannually;
- Group #2: Semiannually;
- Landfarm I: Semiannually; and
- Landfarm III: Semiannually.

The unsaturated zones in the landfarms should be sampled at the following frequencies:

- Landfarm II: Semiannually; and
- Landfarm III: Semiannually.

1.5 PLAN CONTENTS

This sampling and analysis plan has been developed in accordance with the "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD)," OSWER-9550.1, and "Test Methods for Evaluating Solid Waste", EPA SW-846 (latest edition), and the EPA RCRA Ground-Water Monitoring: Draft Technical Guidance, 1992. This plan includes the following components:

- Preparation;
- Safety;
- Field records, sample control, and chain-of-custody;
- Field and laboratory quality assurance/quality control procedures;
- Groundwater sampling procedures;
- Soil sampling procedures;
- Lysimeter sampling Procedures;
- Monitoring well construction and installation specifications;
- Equipment cleaning and decontamination procedures;
- Sample shipping procedures;
- Sample containers, holding times and preservatives;
- Analytical constituents and procedures;
- Pump operation; and
- Use and calibration of field analytical equipment.

2.0 PREPARATION

This Sampling and Analysis Plan has been prepared to assist HOVIC and contracted personnel in collecting representative and consistently reliable data throughout the duration of the sampling program for Landfarms I, II, III, and Lagoons 1 and 2 (West) and 3 (East). This document is intended to provide guidance consistent with the best available technologies and the EPA technical guidance documents. Site specific variations and fluctuating hydrogeologic conditions will dictate the procedures and methodologies to be incorporated during each sampling event. This document is intended to provide a framework within which these event specific considerations can be addressed. This manual will be kept available at the site for field sampling teams.

Preparation of supplies and sampling equipment prior to entering the field is a prerequisite to efficient and accurate sampling. A substantial portion of the sampling procedures consists of gathering and cleaning equipment, preparation of reagents (preservatives) and standards (e.g. for calibrating pH meters), acquiring and labeling appropriate sample containers, and providing complete and timely documentation. The contract analytical laboratory prepares sample containers, labels, chain-of-custody forms and reagents. All sampling devices shall be carefully cleaned before they are used. Cleaning and decontamination procedures for general use in the RCRA sampling program at the HOVIC facility are presented in Appendix B.

3.0 SAFETY

3.1 SAFETY TRAINING

All sampling personnel shall have safety training as identified below:

- 29 CFR, Part 1910, Hazardous Waste Operations and Emergency Response; Final Rule, March 1989 (6). This is the title for the Department of Labor, Occupational Safety and Health Administration (OSHA) regulations governing workers at hazardous waste sites. It covers requirements for training, equipment, and practices involved in specific hazardous waste activities.
- HOVIC Health and Safety Training. This training program is designed to communicate the identification of hazards, safety practices, and communication procedures specific to the HOVIC facility.

The safety program and protocols are further detailed in Appendix C.

3.2 HAZARD ASSESSMENT

Prior to sampling of ground water monitoring wells, the Project Manager will determine the appropriate level of Personnel Protective Equipment, if any are required, by conducting a preliminary assessment. This assessment can include:

- Air Monitoring;
- Detection of Immiscible Layers;

- Product research, description and site history;
- Potential routes of exposure; and,
- Threat to the public health and environment.

Air monitoring, where needed, will consist of an initial background and site perimeter survey and evaluation of the work area. A photoionization detector or an organic vapor analyzer is used to obtain qualitative measurements for assessing the potential threat to the sampling personnel.

A background measurement will be made first in the general vicinity of the well to be sampled. Prior to removing the protective cap from the casing, the air space above the well head will be sampled for organic vapors. If no readings above background are observed, the protective cap will be removed and the air above the well head will be sampled. If any readings significantly above background are detected, the well will be allowed to aerate for five (5) minutes and then the air will be sampled again. All readings will be recorded in the field sampling log. The Project Manager will determine if sampling is to proceed or if additional air monitoring and/or personnel protective equipment is required.

4.0 FIELD RECORDS, SAMPLE CONTROL, CHAIN-OF-CUSTODY

4.1 FIELD LOGBOOKS

Sampling personnel shall use only bound field logbooks for the maintenance of field records. All aspects of sample collection and handling as well as visual observations shall be documented in the field logbooks. All sample collection equipment (where appropriate), field analytical equipment, and equipment utilized to make physical measurements shall be identified in the field logbooks. All calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment shall also be recorded in the field logbooks. All field analyses and measurements must be traceable to the specific piece of field equipment utilized and to the field investigator collecting the sample, making the measurement, or analyses.

All entries in field logbooks shall be dated, shall be legible, and shall contain accurate and inclusive documentation of an individual's project activities. Since field records are the basis for later written reports, language should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. These field logbooks must be maintained as part of project files at the facility.

4.2 SAMPLE LABELS

Sample labels are necessary to prevent misidentification of samples. The labels will be attached to the sample containers and be sufficiently durable to remain legible under wet conditions. The following information will be recorded on the sample labels:

- Facility name and location;
- Sample identification number;
- Place of collection;

- Sample number that uniquely identifies the sample;
- Analysis requested; and
- Preservatives.

Sample labels should be placed on the containers prior to entering the field or prior to collection of the individual sample(s). All applicable information should be completed on the sample label.

4.3 CHAIN-OF-CUSTODY PROCEDURES

4.3.1 General

The possession of samples shall be traceable from the time they are obtained until they are analyzed.

4.3.2 Sample Custody

A sample is in custody if:

- it is in the sampler's or the transferee's actual possession; or
- it is in the sampler's or the transferee's view, after being in his/her physical possession; or
- it was in the sampler's or the transferee's physical possession and then he/she secured it to prevent tampering; or
- it is placed in a designated secure area.

4.3.3 Chain-of-Custody Record

The field Chain-Of-Custody Record is used to record the custody of all samples collected. This form shall be provided by the contracted laboratory. The following information must be supplied in the indicated spaces (Figure 6) in detail to complete the field Chain-Of-Custody Record.

- The project name.
- The sampler and /or sampling team leader must sign in the designated signature block.
- The sampling station number, date, and time of sample collection, grab or composite sample designation, and a brief description of the type of sample and the sampling location must be included. Each line shall contain only those samples collected at a specific location.
- The total number of sample containers must be listed in the indicated space for each sample. The total number of individual containers must also be listed for each type of analysis.

- The label numbers for each sample and any needed remarks are to be supplied in the indicated column.
- The field investigator and subsequent transferee(s) must document the transfer of the samples listed on the Record in the spaces provided at the bottom of the Record. One of the samplers documented under the sampler(s) section must be the person that originally relinquished the samples or a designated field sample custodian who receives secured samples from sampling teams and maintains these samples under secure conditions. Both the person relinquishing the samples and the person receiving them must sign the form; the date and time that this occurred must be documented in the proper space on the Record. Usually, the last person receiving the samples or evidence should be a laboratory sample custodian.

4.3.4 Field Custody Procedures

- All samples must be documented in bound field logbooks.
- A Chain-Of-Custody Record will be completed for all samples.

4.3.5 Transfer of Custody and Shipment

- Samples shall be properly packaged for shipment (Appendix D) and delivered or shipped to the designated laboratory for analyses. Shipping containers shall be secured by using strapping tape and custody seals. The custody seals shall be placed on the container so that it cannot be opened without breaking the seals.
- All samples shall be accompanied by the Chain-Of-Custody Record. The original and one copy of the Record will be placed in a plastic bag inside the secured shipping container if samples are shipped. One copy of the Record will be retained by the field investigator or project leader. The original Record will be transmitted to the field investigator or project leader after samples are accepted by the laboratory.

4.4 LABORATORY LOGBOOK AND CUSTODY PROCEDURES

For samples analyzed in the HOVIC environmental laboratory, the laboratory personnel are responsible for the care and custody of samples from the time they are received until the samples are exhausted or returned for ultimate disposal. All sample preparation, techniques and instrumental methods must be identified in a bound logbook. The results of the analysis of including quality control samples will be identified specific to each batch of ground water samples analyzed. The laboratory logbook will also include the time, date and name of the person who performed each processing step.

5.0 FIELD AND LABORATORY QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

5.1 INTRODUCTION

This section discusses the standard practices and procedures utilized during field operations to ensure the collection of representative samples. The collection of representative samples depends upon:

- ensuring that the sample taken is representative of the material or medium being sampled;
- using proper sampling, sample handling, preservation, and quality control techniques;
- properly identifying the collected samples and documenting their collection in permanent field records (field log books, Chain-Of-Custody Records); and
- maintaining sample chain-of-custody.

The objectives of this section are to present:

- general considerations that must be incorporated in all sampling operations;
- sampling quality assurance procedures; and
- equipment calibration and maintenance requirements for sampling equipment.

5.2 GENERAL CONSIDERATIONS

The following factors and procedures shall be considered and implemented in planning and conducting all sampling operations. All these factors and procedures must be considered in view of specific objectives and scope of each individual sampling event.

5.2.1 Selection and Proper Preparation of Sample Containers

The type of sample container is dictated by the analyses required. Sample containers will be provided by the contracted laboratory. The laboratory will use only EPA approved procedures for preparing containers as outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods," (SW-846), latest edition, and the EPA RCRA Technical Enforcement Guidance Document. The cleanliness of a batch of precleaned bottles should be verified by the contracted laboratory. A listing of containers appropriate to specific analyses is provided in Appendix E.

5.2.2 Sample Preservation

Samples for some analyses must be preserved in order to maintain their integrity. Preservatives required for HOVIC RCRA analyses are provided in Appendix E. All chemical preservatives used by sampling personnel will be supplied by the contracted laboratory. All samples requiring preservation should be preserved immediately upon collection in the field.

An electronic water level indicator shall be used to collect fluid level measurements. After the measurements have been completed and recorded, all equipment should be thoroughly decontaminated, as described in Appendix B, prior to measuring the next monitoring well. The device used to detect the water level measurements should be sufficiently sensitive so that a measurement to ± 0.01 foot can be obtained. Water level measurements should be recorded to the nearest ± 0.01 foot.

Water Level Measurement -- This instrument consists of a spool of dual conductor wire, a probe attached to the end, and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or buzzer attached to the spool will signal the contact. Penlight or 9-volt batteries are normally used for a power source. Measurements shall be made and recorded to the nearest 0.01 foot.

Total Well Depth Measurement -- Weighted tape, or electric water level indicators can be used to determine the total well depth. This measurement is accomplished by lowering the tape or cable until the weighted end is felt resting on the bottom of the well. Because of tape buoyancy and weight effects encountered in deep wells with long water columns, it may be difficult to determine when the tape end is touching the bottom of the well. Care must be taken in these situations to ensure accurate measurements. All total well depth measurements must be made and recorded to the nearest 0.1 foot.

Immiscible Layer Measurement -- Many electronic water level indicators indicate immiscible layers by audible tone and or indicator lights. An intermittent tone indicates the probe is in water, a constant tone indicates the probe is in a LNAPL layer. Measurements should be made to the nearest 0.01 foot.

6.1.3 Equipment Selection

The type of equipment selected to collect ground water samples is a function of the type and size of monitoring well, type of potential pollutant, analytical equipment, and presence or absence of permanent or dedicated pumping fixtures. Ideally, sample withdrawal mechanisms should be:

- Completely inert;
- Economical to manufacture;
- Dedicated or easily decontaminated, cleaned and reused;
- Able to operate at remote sites in the absence of external power sources; and
- Capable of delivering variable flow rates for purging and sample collection.

6.1.4 Organization

The sampling procedure is facilitated by first organizing and setting up required equipment and supplies. The appropriate containers and preservatives required for each sample should be prepared and labeled, and should be ready for sample collection. Additional sample containers

and the required preservatives should be available in the event that the previously prepared containers are broken or inadvertently contaminated.

Well sampling order should be determined as described in Section 6.3. A complete list of the constituents to be sampled and analytical procedures are presented in Appendix F. Instrumentation (e.g. conductivity and pH meters) used to obtain sampling data must be calibrated immediately prior to sampling using laboratory prepared standards. EPA guidelines (e.g. most recent edition Standard Methods) and instructions published by the manufacturer for proper calibration and maintenance procedures for selected equipment should be followed.

6.2 PURGING EQUIPMENT AND TECHNIQUES

6.2.1 General

Wells shall be purged prior to sampling to remove stagnant groundwater from the well and filter pack. Purging should be accomplished by removing groundwater from the wells at a low flow rate using a pump. Wells should be pumped at a maximum rate of 0.3 L/min. At no time should the well be purged to dryness if recharge causes groundwater to cascade down the sides of the well screen.

The intake of the pump should be situated approximately three below the top of the well screen or three feet into the water column, whichever is greater. The well should be purged until measurements of turbidity, dissolved oxygen, pH, and conductivity in in-line analyses of groundwater have stabilized within approximately 10% over two successive measurements made three minutes apart. All analytical measurements and purge times shall be recorded in the field logbook.

6.2.2 Equipment Available

Monitoring well purging is accomplished by using dedicated or portable bladder pumps with dedicated teflon-lined tubing. If the pump is not dedicated to the well, it must be cleaned as specified in Appendix B. Tubing cannot be adequately cleaned and shall not be reused between wells.

Careful consideration shall be given to using pumps to purge wells which are excessively contaminated with oily compounds because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When these type wells are encountered, alternative purging methods, such as bailers, should be considered. The use of bailers must be justified in the field log.

6.2.3 Purging Techniques

Detailed operational instructions for bladder pumps are provided in Appendix G.

6.2.4 Field Care of Purging Equipment

Plastic sheeting shall be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, etc., in the event they need to be placed on the ground during purging or they accidentally come into contact with the ground surface.

6.2.5 Care and Calibration of Field Analytical Equipment

Field analytical equipment used during purging should be cleaned between sample points according to the procedures specified in Appendix B or according to manufacturers instructions. Use and calibration of field analytical equipment is presented in Appendix H.

6.3 COLLECTION OF GROUNDWATER SAMPLES

Monitoring well sampling should progress from the well that is expected to be least contaminated to the well that is expected to be most contaminated. This procedure is followed to minimize the potential for cross-contamination of samples that may result from inadequate decontamination of sampling equipment. Samples should be collected and containerized according to the volatility of the target analytes. The preferred collection order is as follows:

- 1) Volatile organics and total organic halogens;
- 2) Total organic carbon;
- 3) Semi-volatile organics;
- 4) Metals.

The following procedures shall be followed when utilizing groundwater sampling equipment:

- Check valves should be inspected to ensure fouling problems do not reduce delivery capabilities or result in aeration of samples.
- Sampling equipment should never be dropped into the well.
- Decontaminated sampling equipment should not be allowed to come into contact with the ground or other contaminated surfaces prior to insertion into the well.
- Groundwater samples should be collected as soon as possible after the well is purged.
- The rate at which the well is sampled should be 0.1 L/min. Pump lines should be cleared at a rate of 0.1 L/min before collecting samples.
- All sampling activities shall be documented in the field records.

6.4 AUXILIARY DATA COLLECTION

When sampling the Lagoons (during interim status), measurements of pH and specific conductivity must be collected. These measurements should be collected after well purging measurements have stabilized. Record these measurements in the field sampling log.

6.5 GROUNDWATER SAMPLING AND PURGING SUMMARY

A compendium of sample collection requirements and methodologies that will be incorporated at the HOVIC facility is presented below:

1. Calibrate field analytical equipment.
2. Determine sampling sequence.
3. Set up the necessary sampling equipment on a clean level surface that minimizes the threat of contamination.
4. Conduct air monitoring, if necessary, near and around the well head.
5. Record water level, detection of immiscible layers, and well depth information.
6. Commence purging at 0.3 L/min.
7. Measure stabilization parameters until values are within 10% over two measurements collected 2 to 3 minutes apart.
8. Collect sample at 0.1 L/min.
9. Directly transfer the sample to the appropriate container in the sequence as previously presented.
10. Thoroughly clean and decontaminate all equipment and sampling devices.
11. Document all procedures and complete the necessary forms (e.g., sample labels and chain-of-custody).
12. Relocate to the next sampling location.

The groundwater samples will be handled in accordance with the Chain-of-Custody Record, Sample Preservation and Handling, Field Quality Assurance/Quality Control, and Laboratory Quality Assurance/Quality Control procedures, as specified in Sections 4 and 5.

7.0 COLLECTION OF SOIL SAMPLES

The purpose of soil sampling is to monitor the unsaturated zone below Landfarms II and III. The samples are to be collected from a depth of six inches below the treatment zone (five to six feet). The soil samples are to be analyzed for the constituents specified in Appendix F.

7.1 SOIL SAMPLE LOCATION AND SELECTION

Seven soil samples are collected from locations within the bays of Landfarm II and seven soil samples are collected from location within the bays of Landfarm III. The locations of the samples are determined using a random selection process. Grids with a dimension of 50 feet by 50 feet are superimposed over the landfarm bays. Numbers are assigned to each grid square (Figures 7 and 8). A random number generator is used to select seven grid squares in each landfarm. Soil samples will be collected from the approximate center of the grid square selected by the random number.

7.2 SOIL SAMPLE COLLECTION AND FIELD PROCEDURES

The samples will be collected from a depth of within six inches below the base of the treatment zone with a hand auger, power auger, or other similar device. All equipment should

be decontaminated between each sample station as described in Appendix B. The following is the standard step-by-step sample collection procedure for the soil sampling devices employed during sampling operations. If the standard method cannot be employed, alternate acceptable methods are presented in Appendix I.

- Each sampling site will be prepared by scraping away sludge, loose soil clods, rocks, debris, or waste down to the soil interface. Sludge thicknesses and soil boring logs should be recorded in the field logbook.
- Locate tip of auger on the soil surface at the exact sampling location.
- With the auger and drill stem in exactly a vertical position, slowly commence penetration.
- The loose soil should be cleaned away from the auger flights and borehole as drilling proceeds. Penetration depths will be monitored using marks on the drilling rod or measuring the hole with a steel tape.
- When the auger reaches the depth just above the sampling interval, the auger should be moved in and out of the bore hole several times to remove loose material from the sides and bottom of the hole.
- Carefully remove the auger from the bore hole.
- Carefully insert a protective casing into the borehole. The casing is utilized to prevent materials outside of the sampling horizon from falling into the borehole and contaminating the sample.
- Advance a cleaned stainless steel hand auger into the soil to the depth to be sampled. (Six inches below the base of the treatment zone, or five to six feet below ground surface for background samples).
- The top three inches of sample collected in the auger bucket should be discarded.
- The sampling personnel should wear clean, disposable gloves when collecting the sample to prevent outside contamination.
- The sample should be collected by scraping soil from the hand auger into the appropriate container.
- Upon completion, the bore holes should be filled with bentonite to prevent channeling and preferential migration of surface water and sludge materials.

7.3 SAMPLE HANDLING AND PRESERVATION

The soil samples will be handled in accordance with the Chain-of-Custody Record, Sample Preservation and Handling, Field Quality Assurance/Quality Control, and Laboratory Quality Assurance/Quality Control procedures, as specified in Sections 4 and 5.

8.0 COLLECTION OF LYSIMETER SAMPLES

Glass pan lysimeters will be sampled to monitor the soil-pore liquid of the unsaturated zone below Landfarms II and III. The lysimeters are designed to collect soil-pore liquid from a depth of five to six feet below ground surface in areas that could potentially be affected by the landfarm activities. The lysimeters are to be sampled and analyzed for the constituents

specified in Appendix F. A generalized schematic of a glass pan lysimeter is presented in Figure 9.

8.1 SAMPLE COLLECTION AND FIELD PROCEDURES

The lysimeters will be sampled semiannually, following major precipitation events, or following waste application when standing liquids may be present in the bays. Samples collected from the two background lysimeters should be composited and handled in the same manner as the other lysimeter samples. The collection method for the pan lysimeter requires a 1000 mL glass Erlenmeyer flask with a tubing port, glass tubing, Teflon tubing, a rubber stopper, and a two way hand pump. Figure 10 depicts the collection assembly. The locations of the lysimeters to be sampled are presented in Figures 4 and 5. The following procedure will be used to sample the glass pan lysimeters:

- Connect the plastic sample collection hose to an Erlenmeyer flask with a piece of neoprene tubing.
- Connect the vacuum side of the pump to the other side of the Erlenmeyer flask. The glass collection tube contained in the flask should be placed within 0.4 inches of the bottom. This will minimize the potential for volatilization during sample collection.
- Apply a vacuum of 70-80 centibars to the flask.
- Allow the flask to fill to 2/3 of its capacity or until no further sample is obtainable.
- After sufficient amount of sample has been collected and saved, continue to pump the system to remove all water from the lysimeter.
- Record the total volume of liquid removed.
- Transfer a sample to the sample container.
- Preserve the sample, if necessary.
- Cap each container and attach the sample label and seal.
- The container should be labelled and the all paper work completed, i.e. chain-of-custody form and sample analysis request form.

8.2 SAMPLE HANDLING AND PRESERVATION

The lysimeter samples will be handled in accordance with the Chain-of-Custody Record, Sample Preservation and Handling, Field Quality Assurance/Quality Control, and Laboratory Quality Assurance/Quality Control procedures, as specified in Sections 4 and 5.

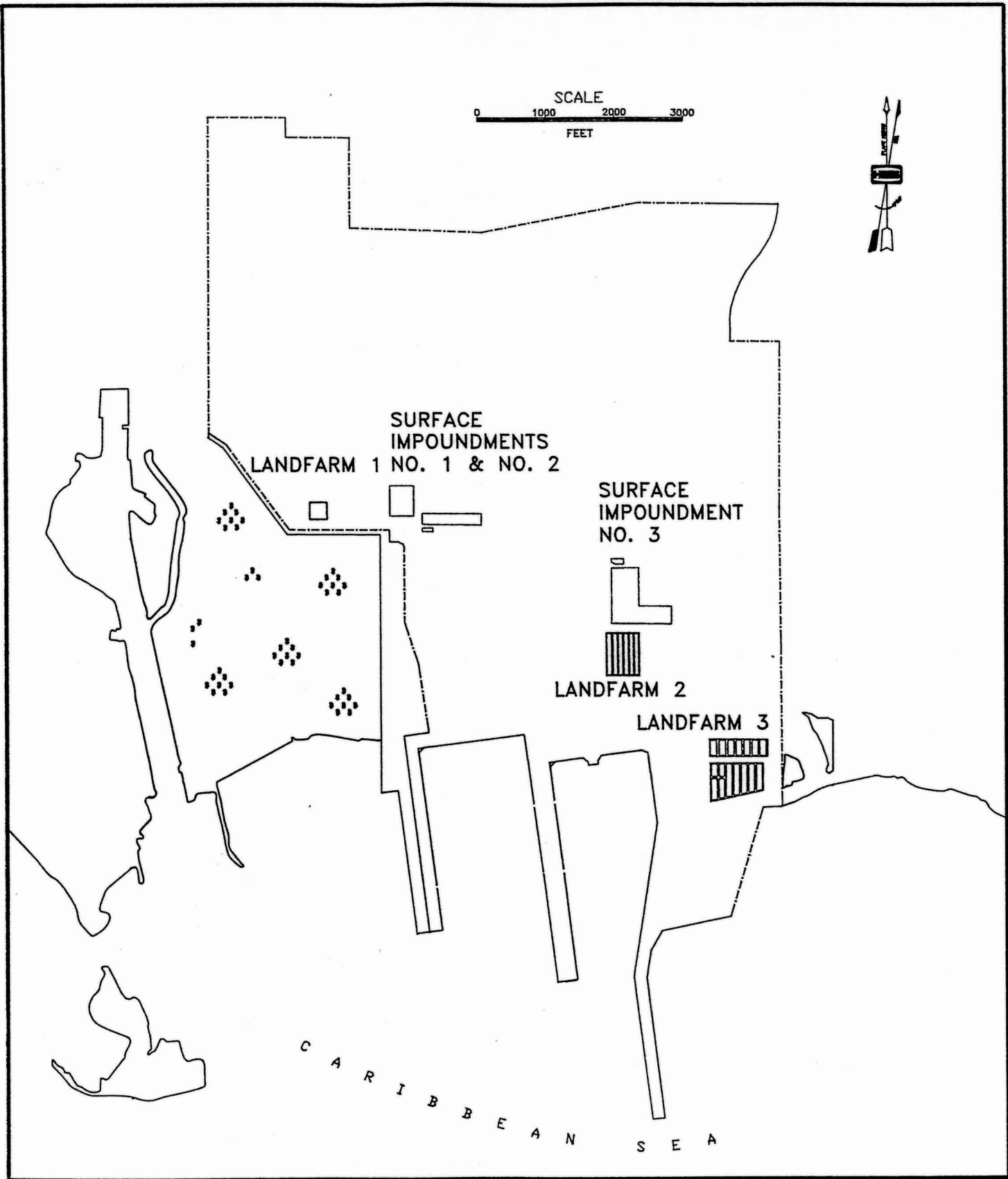


FIGURE 1

Drawn By: AMB	Date: 7/18/94	Scale: AS SHOWN
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HOVIC
RCRA UNIT LOCATIONS

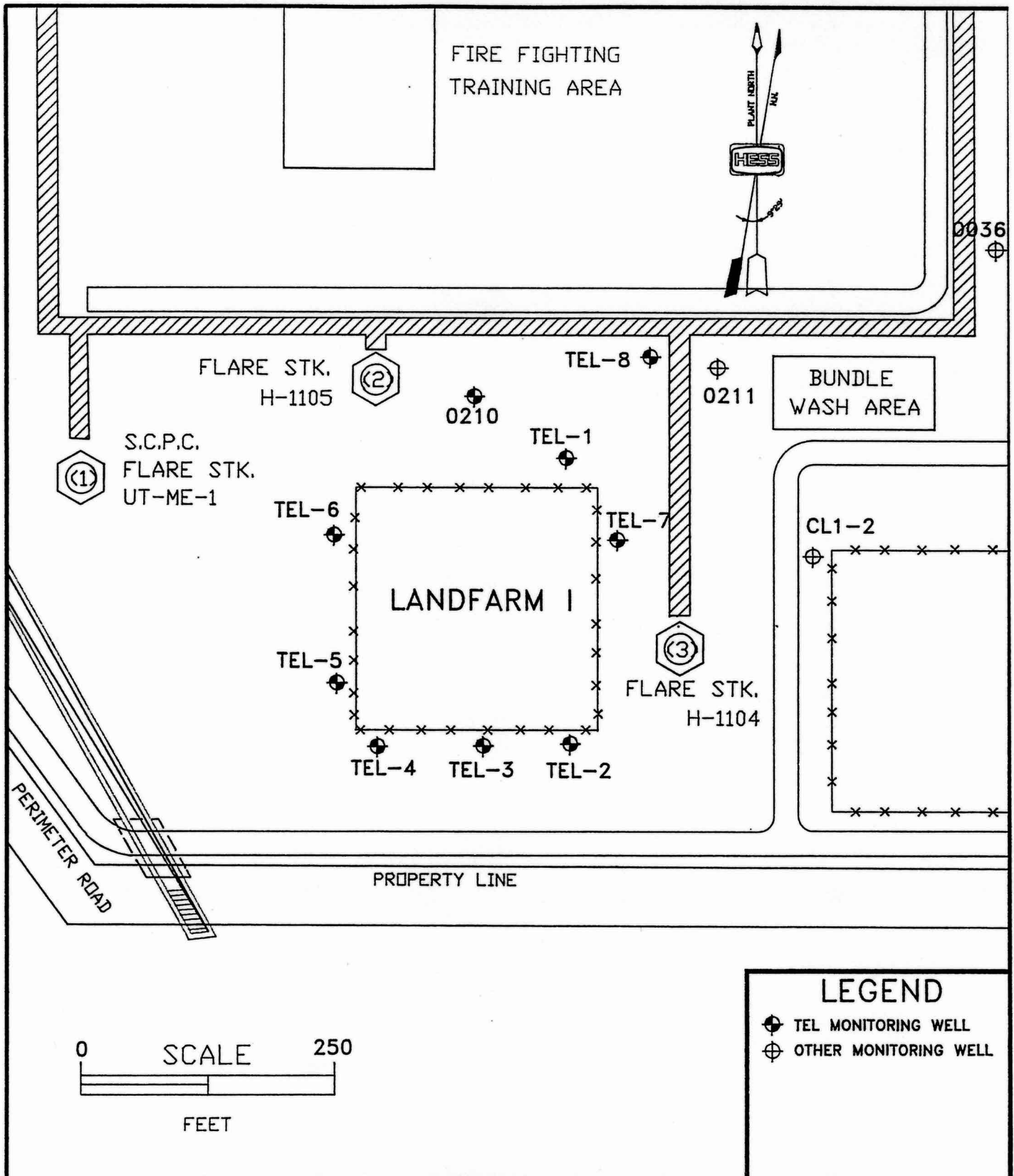


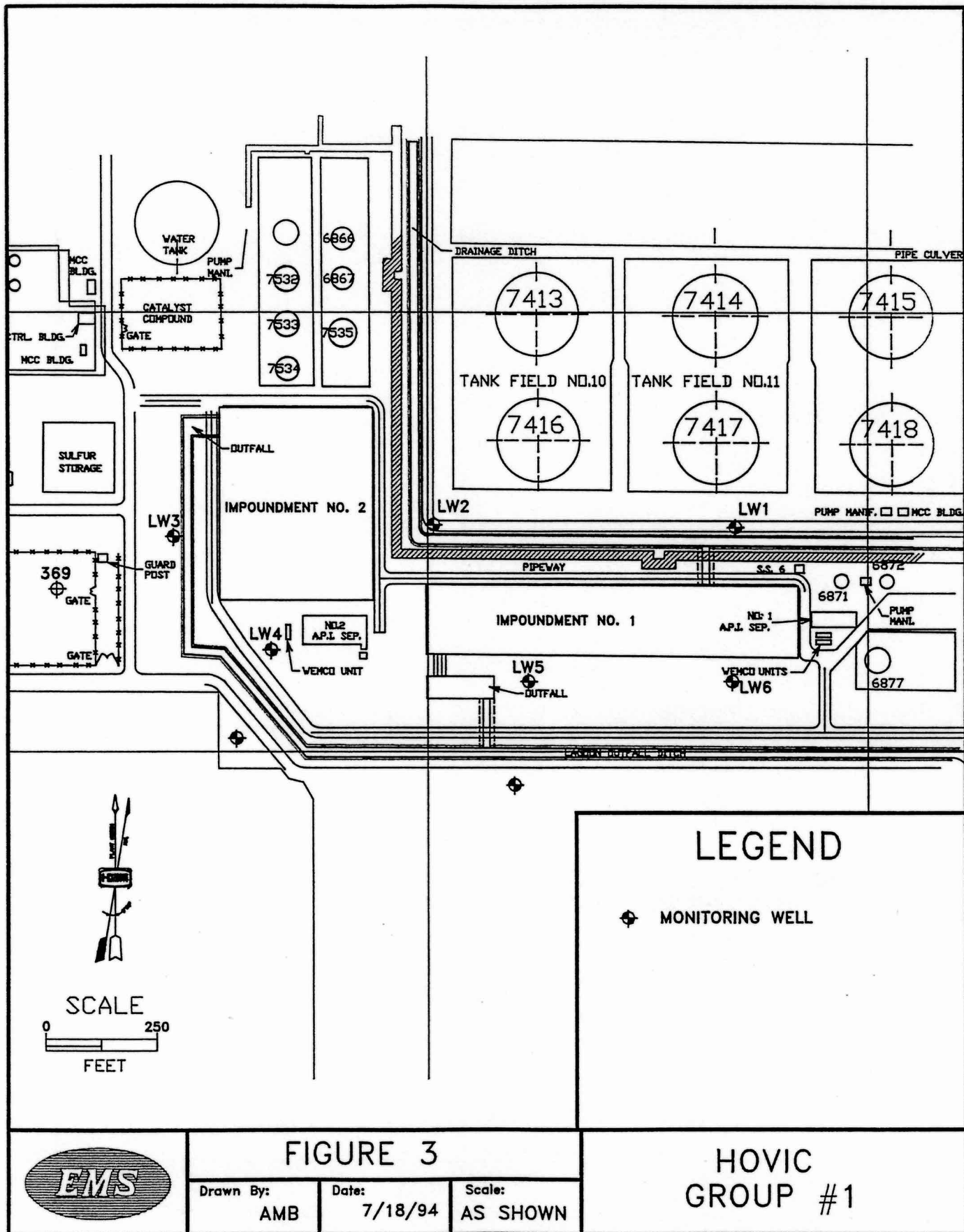
FIGURE 2

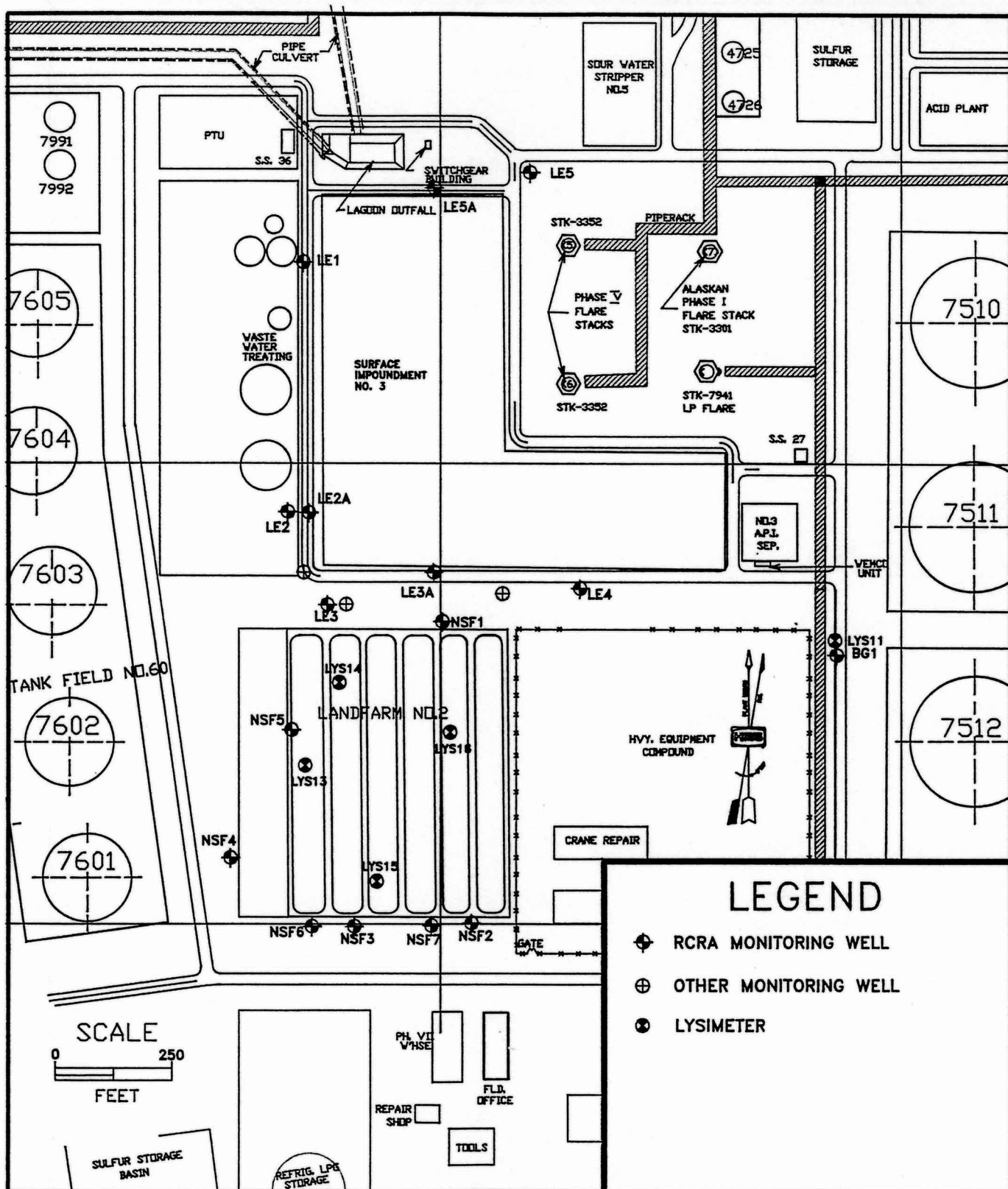
Drawn By:
AMB

Date:
7/18/94

Scale:
AS SHOWN

HOVIC
LANDFARM I





LEGEND

- ⊕ RCRA MONITORING WELL
- ⊕ OTHER MONITORING WELL
- ⊗ LYSIMETER

FIGURE 4

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AMB

Date:
7/18/94

Scale:
AS SHOWN

HOVIC
GROUP #2



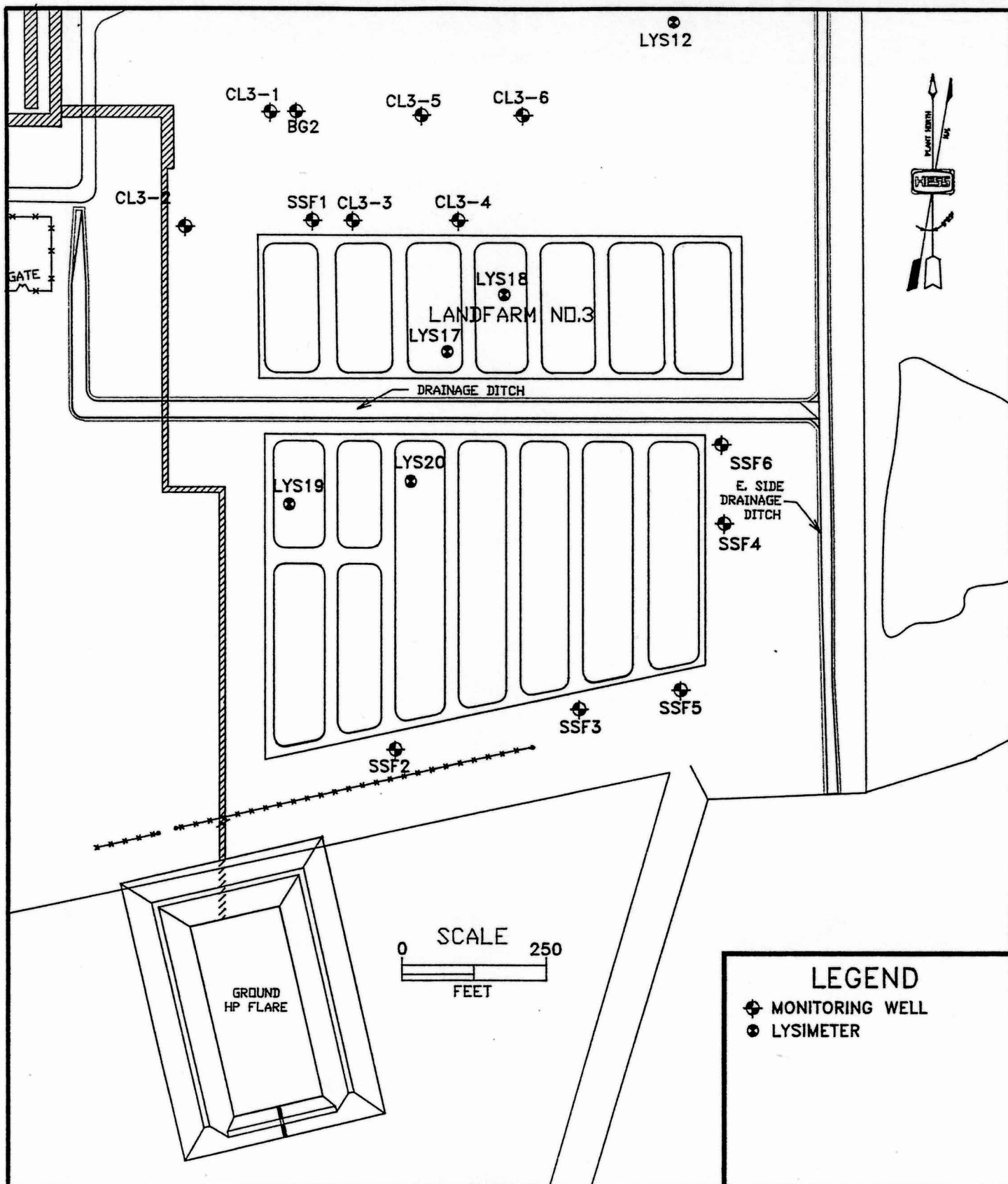


FIGURE 5

HOVIC
LANDFARM III

Drawn By:
AMB

Date:
7/18/94

Scale:
AS SHOWN



CHAIN OF CUSTODY

CLIENT _____ BILL TO: _____
 ADDRESS _____
 CITY _____ STATE/ZIP _____
 ATTENTION _____ TELEPHONE _____ REQUESTED TURN AROUND:
 _____ 1 WEEK _____ 2 WEEKS _____ 3 WEEKS

JOB NO: _____
 PROJECT NO: _____
 FACILITY NAME: _____

LABORATORY ID	DATE SAMPLED	TIME SAMPLED	SMPL BY	MAT RIX	NO. CONT	PRES	FIELD ID / POINT OF COLLECTION	ANALYSES REQUESTED

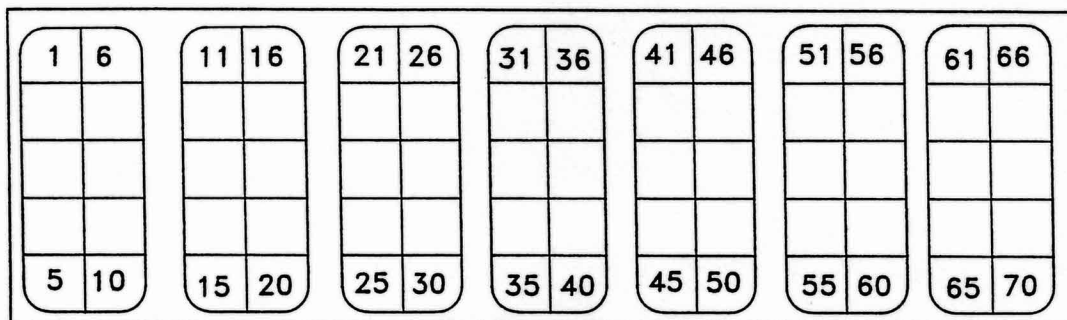
1. RELINQUISHED BY:	DATE/TIME:	1. RECEIVED BY:	3.RELINQUISHED BY:	DATE/TIME:	3.RECEIVED BY:	SAMPLE LOCATION:
2. RELINQUISHED BY:	DATE/TIME:	2. RECEIVED BY:	4.RELINQUISHED BY:	DATE/TIME:	4.RECEIVED BY:	
DELIVERABLE PACKAGE(check one) REDT2 _____ COMMB _____ FULTI _____ COMMA _____ OTHER _____						COMMENTS:

FIGURE 6

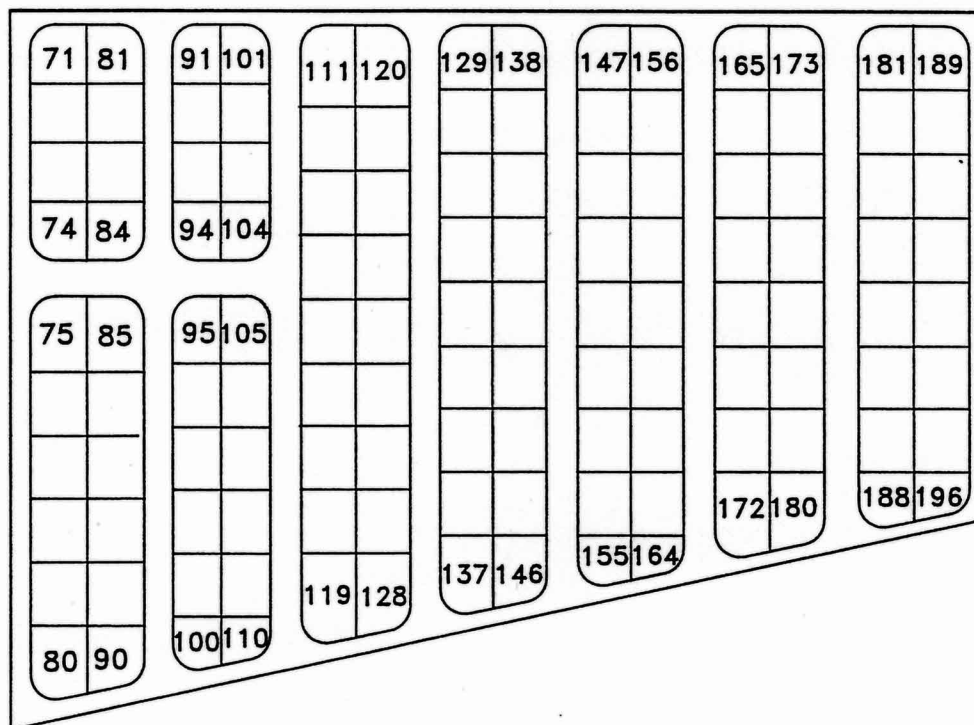


AS SHOWN

HOVIC
LANDFARM NO.2
SAMPLING GRID



← DRAINAGE DITCH



0 SCALE 100
FEET



FIGURE 8

Drawn By:
AMB

Date:
7/18/94

Scale:
AS SHOWN

HOVIC
LANDFARM NO.3
SAMPLING GRID



Drawn By: AMB

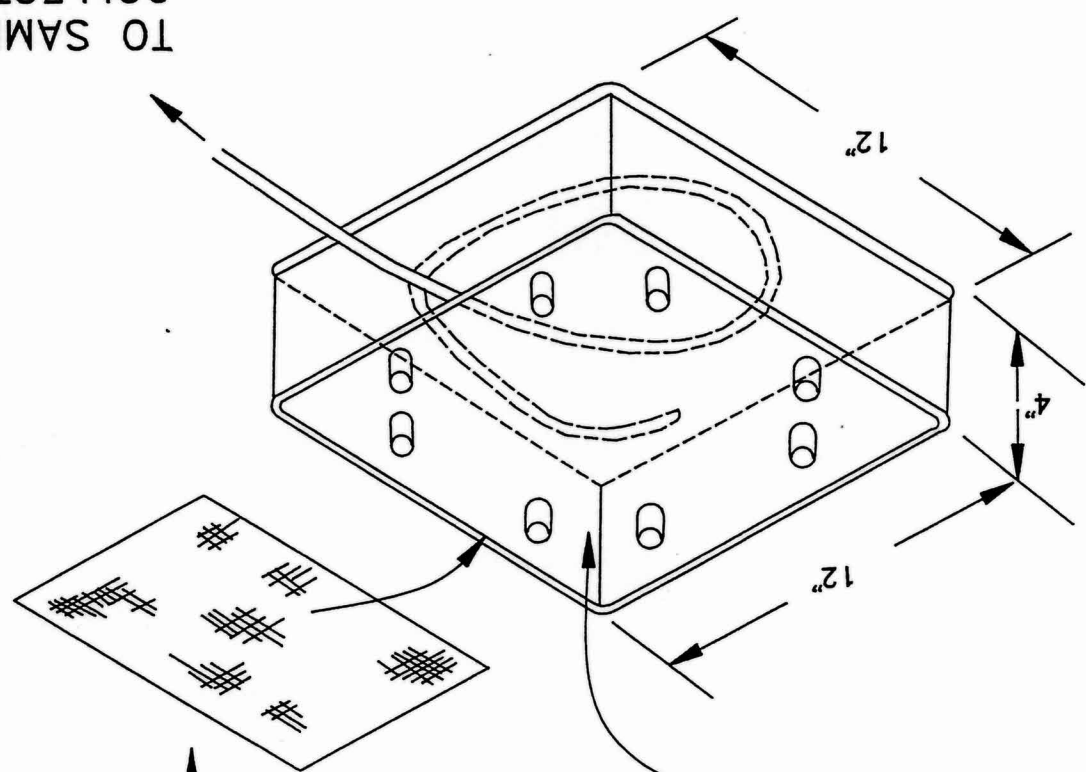
Date: 7/27/94

Scale: NTS

SCHEMATIC
GLASS PAN LYSIMETER

FIGURE 9

TO SAMPLE
COLLECTION
EQUIPMENT



HOLLOW SAMPLE
STORAGE AREA

GEOTEXTILE FIBER

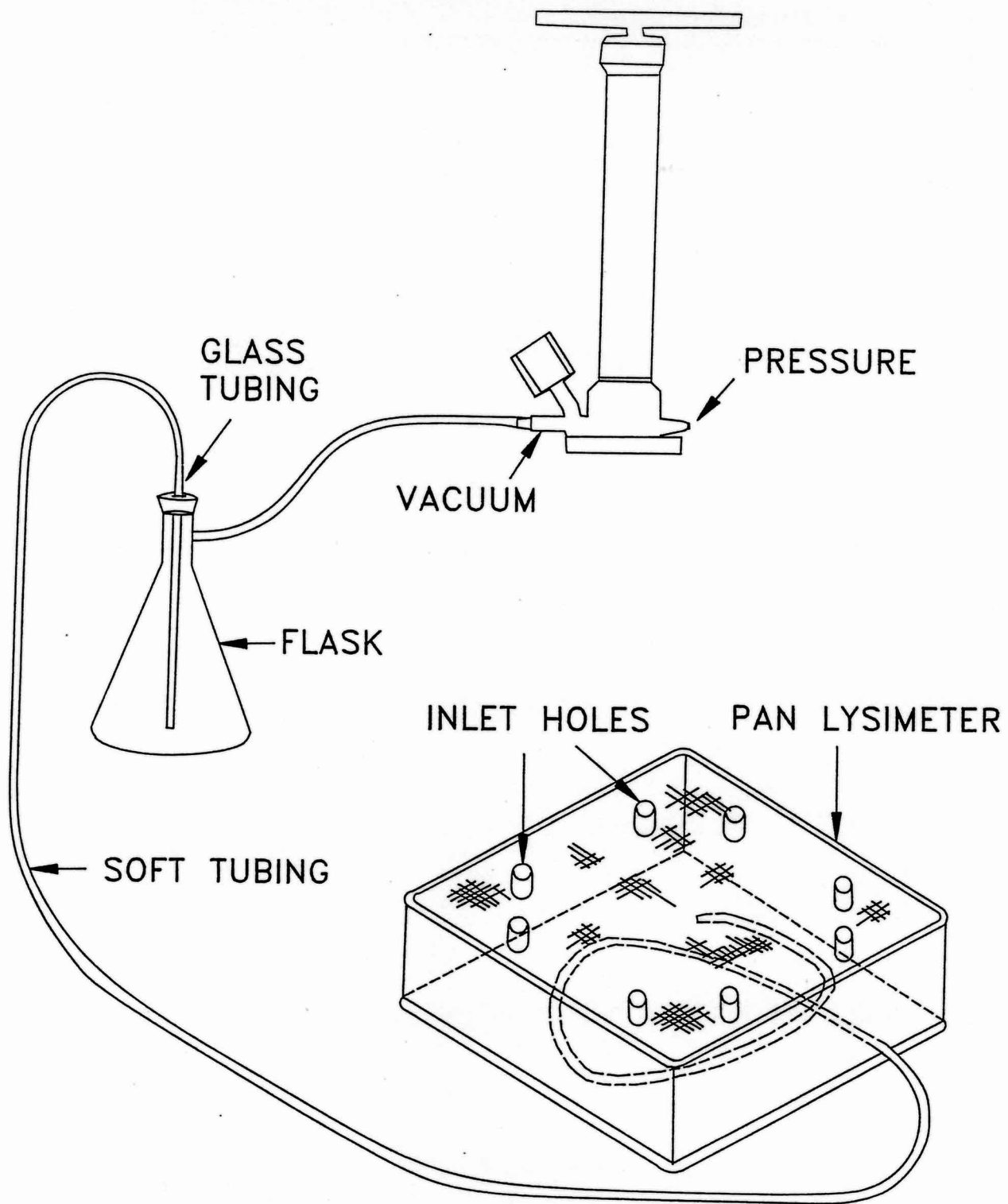


FIGURE 10

SCHEMATIC
LYSIMETER SAMPLE
COLLECTION ASSEMBLY

EMS

Drawn By:
AMB

Date:
7/27/94

Scale:
NTS

APPENDIX A

MONITORING WELL CONSTRUCTION AND INSTALLATION SPECIFICATIONS

A.1 INTRODUCTION

The design and installation of permanent monitoring wells involve the drilling of boreholes into various types of geologic formations that exhibit varying subsurface conditions. Designing and installing permanent monitoring wells in these geologic environments may require several different drilling methods and installation procedures. The selection of drilling methods and installation procedures shall be based on field data collected during a hydrogeologic site investigation and/or a search of existing data. Each permanent monitoring well shall be designed and installed to function properly throughout the entire anticipated life of the monitoring program. When designing monitoring wells the following questions shall be considered:

- What are the short- and long-term objectives?
- How long will the monitoring program last?
- What contaminants are to be monitored?
- What types of well construction materials are to be used?
- What kinds of analyses are needed?
- What are the surface and subsurface geologic conditions?
- What aquifer(s) is going to be monitored?
- Over what depth(s) will the well be screened?
- What is the anticipated total depth of the well?
- What are the general site conditions?
- What are the potential health and safety hazards?
- Are these wells going to serve more than one purpose (i.e., monitoring, pump test, extraction)?

The previous questions can be expanded into many subtopics depending on the complexity of the project. In designing permanent monitoring wells, the most reliable obtainable data shall be utilized. Once the data have been assembled and the well design has been completed, a drilling method(s) has to be selected. The preferred drilling procedure for installing wells is the hollow-stem auger method. However, site conditions may not always be amenable to using

the hollow-stem auger method. When this occurs, an alternate method shall be selected that will perform acceptably under the encountered site conditions. It is advisable to select several alternate methods and be prepared to use them if a field problem suddenly occurs that warrants a drilling change. The following procedures for designing and installing monitoring wells cover the different aspects of selecting materials, drilling boreholes, and installing monitoring devices. This discussion is presented so that standard practices and procedures will be employed by all who are associated with the design, drilling, and installation of permanent monitoring wells at the facility.

Existing Monitoring Well Design

Ground water monitoring wells installed around the regulated units at the facility are constructed of either 2 or 4-inch diameter schedule 40 PVC or stainless steel casing equipped with a 10-foot section of slotted 2 or 4-inch diameter schedule 40 PVC or stainless steel screen. The casing joints are threaded and no adhesives were used in the construction of the wells. The slot opening for the monitoring well screens are 0.01 or 0.02 inch. The annular space of the screened interval for each well was backfilled with a gravel pack to a level approximately five feet above the top of the screen. A bentonite plug, with a minimum one foot thickness was placed on top of the gravel pack.

A.2 DRILLING METHODS

The following drilling methods are listed in order of preference; however, final selection shall be based on actual site conditions.

A.2.1 Hollow-stem Auger

This type of auger consists of a hollow, steel stem or shaft with a continuous, spiralled steel flight, welded onto the exterior side of the stem, connected to an auger bit, which when rotated, transports cuttings to the surface. This method is best suited in soils that have a tendency to collapse when disturbed.

A monitoring well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils and/or water table. However, retracting augers in caving sand conditions while installing monitoring wells can be extremely difficult or impossible since the augers have to be extracted without being rotated. If caving sands are encountered during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without rotating them. A bottom plug or pilot bit assembly can be fastened onto the bottom of the augers to keep out most of the soils and/or water that have a tendency to clog the bottom of the augers during drilling. Potable water may be poured into the augers (where applicable) to equalize pressure so that the inflow of formation materials and water will be held to a minimum when the bottom plug is released. Water-tight center plugs are not acceptable because they create suction when being extracted from the augers. This suction forces or pulls cuttings and formation materials into the augers, thus defeating the purpose of the centerplug. Auguring without a center plug or pilot bit assembly is permitted, provided that the soil plug which is formed in the bottom of the auger is removed when sampling or installing well casings. Removing the soil plug from the augers can be

accomplished by washing out the plug using a side discharge rotary bit, or augering out the plug with a solid-stem auger bit sized to fit into the hollow-stem auger. The type of bottom plug or pilot bit assembly proposed for the drilling activity shall be approved by the supervising Geologist prior to drilling operations. Boreholes can be augered to depths of 150 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

A.2.2 Solid-stem Auger

This type of auger consists of a solid stem or shaft with a continuous spiralled steel flight, welded onto the stem, and connected to an auger bit. When rotated, cuttings are transported to the surface. This auger method is used in cohesive and semi-cohesive soils that do not have a tendency to collapse when disturbed. Boreholes can be augered to depths of 200 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 150 feet.

Both of the previously discussed auger methods can be used in unconsolidated soils and semi-consolidated (weathered rock) soils, but not in competent rock. Each method can be employed without introducing foreign materials into the borehole such as drilling fluids, thus minimizing the potential for cross-contamination. Minimizing the risk of potential cross contamination is one of the most important factors to consider when selecting the drilling method(s) for a project.

A.2.3 Rotary Method

This method consists of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through the soils. The cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids which generally consist of water, drilling mud, or air. The water, drilling mud, or air is pumped down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are forced to the surface between the borehole wall and the drill pipe. The drilling fluids not only force the cuttings to the surface but also keeps the drilling bit cool. When considering this method, it is important to evaluate the potential for contamination when fluids and/or air are introduced into the borehole. If the rotary method is selected as one of the drilling methods, water rotary is the preferred method, followed by air rotary and mud rotary.

A.2.3.1 Water Rotary -- When using water rotary, potable water shall be used. If potable water (or a higher quality water) is not available, then potable water will have to be transported to the site or an alternative drilling method must be selected. Water rotary is the preferred rotary method because potable water is the only fluid introduced into the borehole during drilling. Water does not clog the formation materials, thus reducing well development time. The potable water will, however, flow out into the surrounding formation materials (if permeable) and mix with the natural formation water. This mixing of the drilling water and the natural formation water should be evaluated when determining the drilling method. Generally, most of the drilling water will be recovered during well development.

A.2.3.2 Air Rotary -- When using air rotary, the air compressor shall have an in-line organic

All samples preserved with chemicals shall be clearly identified by indicating on the sample label and chain of custody that the sample is preserved. If samples normally requiring preservation were not preserved, field records shall indicate why.

5.2.3 Sample Holding Times

The elapsed time between sample collection and initiation of laboratory analyses must be within a prescribed time frame for each individual analysis to be performed. Sample holding times are shown in Appendix E.

5.2.4 Special Precautions for Trace Contaminant Sampling

Some contaminants can be detected in the parts per billion and/or parts per trillion range. Extreme care must be taken to prevent cross-contamination of these samples. The following precautions shall be taken when trace contaminants are of concern:

- A clean pair of new, disposable gloves will be worn each time a different location is sampled and gloves should be donned immediately prior to sampling.
- If possible, one member of the field team should take all the notes, fill out sample labels, etc., while the other members collect all of the samples.
- Sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area.
- Sampling personnel should use equipment constructed of Teflon®, stainless steel, or glass that has been properly precleaned (Appendix B) for collecting samples for trace metals or organic compounds analyses. Teflon® or glass is preferred for collecting samples where trace metals are of concern. Equipment constructed of plastic or PVC shall not be used to collect samples for trace organic compounds analyses.

5.2.5 Sample Handling and Mixing

Samples requiring analysis for organics will not be filtered or transferred from one container to another in order to minimize the potential for losses of organic constituents through aeration and subsequent volatilization. No headspace should exist in sample containers for total organic halogens (TOX), total organic carbon (TOC), or volatile organics (VOA). Each of these types of samples will be immediately inspected after it has been collected in order to verify that **NO HEADSPACE** is present. Any deviation from these procedures should be documented in the field sampling log.

After collection, all sample handling should be minimized. Extreme care should be used to ensure that samples are not contaminated. If samples are placed in an ice chest, personnel should ensure that melted ice cannot cause sample containers to become submerged, as this may result in sample cross-contamination. Plastic bags, such as Zip-Lock® bags, should be used when small sample containers (e.g., VOA's) are placed in ice chests to prevent cross-contamination.

5.2.6 Purgeable Organic Compounds Sampling (VOA)

Water samples to be analyzed for purgeable organic compounds should be stored in 40-ml septum vials with screw cap and Teflon®-silicone disk in the cap to prevent contamination of the sample by the cap. The disks should be placed in the caps (Teflon® side to be in contact with the sample) in the laboratory prior to the beginning of the sampling program.

The vials (40-ml) should be completely filled to prevent volatilization, and extreme caution should be exercised when filling a vial to avoid any turbulence which could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a "convex meniscus." The cap is then applied and some overflow is lost, but air space in the bottle is eliminated. After capping, turn the bottle over and tap it to check for bubbles. If any bubbles are present, repeat the procedure. When collecting water samples for purgeable organic compounds, triplicate samples should always be collected from each location. Three 40-ml vials containing four drops of concentrated HCl should be filled the with sample.

Soil and sediment samples collected for purgeable organic compounds analyses should not be mixed. The 2-ounce (60-ml) sample container should be filled completely; no head space should remain in the sample containers.

5.2.7 Sample Identification

All samples will be fully documented, as outlined in Section 4, in the field records, on the field sample Chain-Of-Custody Record, and on the sample tags.

5.2.8 Collection of Auxiliary Data

All auxiliary data such as meteorological conditions and other observations shall be entered onto the field records when the auxiliary data are collected. Auxiliary data relative to a particular sampling location should be collected as close to the sample collection time as possible. Specific types of auxiliary data to collect for each medium sampled are discussed later in this section.

5.2.9 Time Records

All records of time shall be kept using local time in the 2400 hour time format and shall be recorded to the nearest minute.

5.3 SPECIFIC SAMPLE COLLECTION QUALITY CONTROL PROCEDURES

5.3.1 General

This subsection provides guidelines for establishing quality control procedures for sampling activities. Specific guidelines for selection of sampling equipment, standard sample collection procedures, and calibration procedures for sampling equipment, and other considerations are presented for each medium later in this manual. Strict adherence to all of the standard operating procedures outlined in this manual form the basis for the sampling quality assurance program.

5.3.2 Experience Requirements

There is no substitute for field experience. Therefore, all professional and paraprofessional employees shall have the equivalent of six months field experience before they are permitted to conduct sampling on their own initiative. This field experience shall be gained by on-the-job training using the "buddy" system. Each new field employee shall accompany an experienced employee on as many different types of sampling events as possible. During this training period, the new employee will be permitted to perform all facets of field investigations, including sampling, under the direction and supervision of senior technical staff.

5.3.3 Traceability Requirements

All sample collection activities shall be traceable through field records to the person collecting the sample and to the specific piece of sampling equipment (where appropriate) used to collect that sample. All maintenance and calibration records for sampling equipment (where appropriate) shall be kept so that they are similarly traceable.

5.3.4 Measurement of Relative Sampling Precision

The following duplicate sampling procedures shall be used during the collection of HOVIC samples as a relative measure of the precision of the sample collection and analytical process. A blind duplicate sample from a randomly selected well should be obtained for each sampling event. When sampling Landfarm I wells, duplicate samples must be taken at a frequency of at least five percent. These blanks will have no special numerical identification and shall be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as the required samples. They shall also be preserved in the same manner and submitted for the same analyses as the required samples.

These data will be examined by the project leader to determine if any problems are evident with specific types of media samples or with the procedures used by specific personnel. The project leader will notify the sample team leader and laboratory of any problems encountered so that corrective action can be taken.

5.3.5 Measurement of Sample Handling Effectiveness

The effectiveness of sample handling techniques will be monitored by utilizing blank samples. The following blank samples are required:

- Water Sample VOA Trip Blank -- A water sample VOA trip blank is required for every event where water samples are collected for VOA analysis. At least one sealed preserved (or unpreserved if appropriate) 40-ml VOA vial will be transported to the field. These field blanks will be handled and treated by sampling personnel in the same manner as the water samples collected for purgeable organic compounds analysis on that particular sampling event. These samples will be clearly identified on sample labels and Chain-of-Custody Records as trip blanks.

Any contaminants found in the trip blank could be attributed to:

- Interaction between the sample and the container;
- Contaminated rinse water; or,
- A handling procedure that alters the sample analysis.

- **Soil Sample VOA Trip Blank** -- A soil sample VOA trip blank is required for every sampling event where soil samples are collected for purgeable organic compounds analysis. One soil VOA vial will be transported to the field. This field blank will be handled and treated by sampling personnel in the same manner as the soil samples collected for purgeable organic compounds analysis. These samples will be clearly identified on sample labels and Chain-Of-Custody Records as trip blanks.
- **Field Blank** -- Field blanks are prepared by pouring laboratory-supplied analyte-free water from the original container into laboratory-supplied sample bottles in the field between sampling locations. These samples will be clearly identified as field blanks on sample labels and in the Chain-Of-Custody Record(s). These blanks are prepared to ensure that contamination of samples is not occurring from the sampling activities. A minimum of one field blank for each day or partial day comprising a sampling event is required.

5.3.6 Measurement of Sample Equipment Cleaning Procedures

If non-dedicated soil or groundwater sampling equipment is used, a minimum of one equipment blank will be collected for each sampling event to ensure that non-dedicated sampling equipment has been effectively cleaned and/or decontaminated. These blanks are transferred to a sample bottle after being exposed to the cleaned and/or decontaminated equipment and returned to the laboratory for analysis. The rinsewater will be containerized, preserved and submitted for the same analyses as the other samples collected. These samples will be clearly identified as equipment blanks on sample labels and in the Chain-Of-Custody Record(s). A minimum of one equipment blank for each day or partial day comprising a sampling event is required.

5.4 LABORATORY QA/QC

HOVIC contracts an outside laboratory to perform most laboratory analyses during the ground water monitoring period. The laboratory is responsible for implementing a QA/QC program consistent with recommended EPA methodologies and procedures (particularly EPA SW-846, most recent edition) and as a minimum this includes the following components:

- | | |
|---------------------|--------------------------|
| ■ Standards | ■ Laboratory blanks |
| ■ Duplicates | ■ Spiked samples |
| ■ Operator Training | ■ Instrument Maintenance |

The QA/QC program of the laboratory will include sections describing:

- Laboratory Methodologies;
- Personnel Qualifications;
- Analytical Methods; and,
- Holding Times.

To ensure that the lab has an adequate QA/QC program in place. The following procedures may be required:

- Examine Copy of QA/QC Program on the Laboratory Premises;
- Conduct Periodic Visits to the Laboratory;
- Submit Replicate Samples; and,
- Verify Personnel Qualifications.

5.4.1 Chemical Laboratory

Any lab retained by HOVIC to perform these analyses should be able to provide typical laboratory methodologies and personnel qualifications. Holding times for the constituents to be analyzed in the laboratory are presented in Appendix E. All data developed shall be properly validated and the results of all QA/QC samples presented.

5.4.2 Data Reduction and Reporting

Data should be reported according to accepted practices of quality assurance and data validation as outlined in EPA SW-846, most recent edition. The following data should be included:

- Replicate samples;
- QA/QC samples (including calibration samples and spikes);
- Identification of outlier values;
- Method detection limits; and,
- Reporting of results determined to be below detection limits.

Reports including interim, progress, draft and final reports may be necessary for specific activities that are performed during the ground water monitoring program. Reporting will include any exceedences in holding times and measures taken to avoid holding time problems for subsequent sampling events.

6.0 GROUND WATER SAMPLING

The purpose of groundwater sampling is to monitor the uppermost aquifer in the area of the RCRA regulated areas. The samples are to be collected from monitoring wells surrounding these units as specified in Section 1.4. The samples are to be analyzed for the constituents specified in Appendix F.

6.1 PRE-SAMPLING ACTIVITIES

6.1.1 Sampling Sequence

In general, up-gradient/background wells are always sampled first, followed in order of ascending concentrations of parameters being evaluated, based on historical sample data. This procedure is followed to minimize the potential for cross-contamination of samples that may result from inadequate decontamination of sampling equipment.

6.1.2 Fluid Level Elevations

Measurements of static fluid levels in each well must be made prior to each sampling event. Measurements will be made to detect the presence and measure the thickness of any immiscible layers and to measure the depth of standing water and the depth to the bottom of the intake screen structure. Measurements will be made from a reference mark at the top of the inner well casing adjacent to the lock to ensure consistency of measurement between sampling events. For Group East, Group West, and Landfarm III, certain monitoring wells serve only as piezometers. These are wells NSF-1, NSF-3, LW-2, LE-2, LE-2A, LE-3, LE-3A, LE-4, LE-5, SSF-1, SSF-3, and SSF-4.

filter system to filter the air coming from the compressor. The organic filter system shall be regularly inspected to insure that the system is functioning properly. Air compressors that do not have in-line organic filter systems are not acceptable for air rotary drilling.

A.2.3.3 Mud Rotary -- Mud rotary is the least preferred rotary method because contamination can be introduced into the borehole from the constituents in the drilling mud, and it is very difficult to remove the drilling mud from the borehole after drilling and during well development. The drilling mud can also carry contaminants from a contaminated zone to an uncontaminated zone, thereby cross-contaminating the borehole. If mud rotary is selected, only potable water and pure (no additives) bentonite drilling muds shall be used.

A.2.4 Other Methods

Other types of drilling procedures are also available, such as the cable-tool, the jetting method, and the boring (bucket auger) method. These methods are used in the installation of water and irrigation wells, but are not common methods for monitoring well installations. If these methods are selected for monitoring well installations, they shall be approved by a senior staff geologist before field work is initiated.

A.3 BOREHOLE REQUIREMENTS

A.3.1 Annular Space

The borehole shall be of sufficient diameter so that well construction can proceed without major difficulties. To assure adequate size, a minimum 2-inch annular space is required between the casing and the borehole wall (or the hollow-stem auger wall). For example, an 8-inch borehole is required to install a 4-inch outside diameter (OD) casing. However, if the inside diameter (ID) of the casing is 4 inches, the borehole will have to be larger than 8 inches to include the 2-inch annular space and the outside diameter (OD) of the casing (4-inch ID plus the casing wall thickness). The 2-inch annular space around the casing will allow the filter pack, bentonite pellet seal, and the annular grout to be placed at an acceptable thickness. Also, the 2-inch annular space will allow up to a 1.5-inch diameter tremie tube for placing the filter pack, pellet seal, and grout at the specified intervals. An annular space less than the 2-inch minimum will not be acceptable. When installing a well inside of hollow-stem augers, the inside diameter (ID) of the augers is the area to be considered when determining the 2-inch annular space.

A.3.2 Overdrilling The Borehole

Sometimes it is necessary to overdrill the borehole so any soils that have not been removed or have fallen into the borehole during auger or drill stem retrieval, will fall to the bottom of the borehole below the depth where the filter pack and well screen are to be placed. Normally, 3 to 5 feet is sufficient for overdrilling. The borehole can also be overdrilled to allow for placement of a sump in the well below the well screen. A sump usually consists of a 5- or 10-foot section of well casing located below the well screen. Sumps serve as catch basins

or storage areas for sediment that flows into the well and drops out of suspension and for high density non-aqueous phase liquids. Sumps are added to the well screens when the wells are screened in aquifers that are naturally turbid and will not yield clear formation water (free of visible sediment) even after extensive development. The sediment can then be periodically pumped out of the sump preventing the well screen from clogging or "silting up". If the borehole is overdrilled too much, it can be backfilled to the designed depth with bentonite pellets or the filter sand that is to be used for the filter pack.

A.3.3 Filter Pack Placement

When placing the filter pack into the borehole, a minimum of 6 inches of the filter pack material shall be placed under the bottom of the well screen to provide a firm footing and an unrestricted flow under the screened area. Also, the filter pack shall extend a minimum of two feet above the top of the well screen. The filter pack shall be placed by the tremie or positive displacement method. Placing the filter pack by "pouring" may be acceptable in certain situations; however, this will be discussed in the next section.

A.3.4 Filter Pack Seal-Bentonite Pellet Seal (Plug)

A seal shall be placed on top of the filter pack. This seal shall consist of a high solids, pure bentonite material. The solids content shall be at least 20 percent. Bentonite materials that have a solids content of 20 percent or greater are available in powder form or in the form of pellets compressed to a density of 70-80 lbs/cu.ft. The preferred method of placing bentonite pellets is by the positive displacement or the tremie method. Use of the tremie method minimizes the risk of pellets bridging in the borehole and assures the placement of pellets (also sand and grout) at the proper intervals. Pouring of the pellets (and filter pack materials) is acceptable in shallow boreholes (less than 50 feet) where the annular space is large enough to prevent bridging and to allow measuring (with a tape measure) to insure that the pellets have been placed at the proper intervals. The bentonite seal shall be placed above the filter pack at a minimum of two feet vertical thickness. In all cases, the proper depths shall be documented by measuring and not by estimating. Other forms of bentonite such as granular bentonite, and bentonite chips have limited applications, and are not recommended for the bentonite seal unless special conditions warrant their use. In any case, deviation from bentonite pellets for the seal, such as a 30 percent solids bentonite grout, shall be approved by a senior staff geologist.

A.3.5 Grouting The Annular Space

The annular space between the casing and the borehole wall shall be filled with either a high solids, pure (no additives), bentonite grout, a neat cement grout, or a cement/bentonite grout. Each type of grout to be used shall be evaluated as to its intended use and integrity. The grout shall be placed into the borehole, by the tremie method, from the top of the bentonite seal to within 2 feet of the ground surface. The tremie tube shall have a side discharge port or a bottom discharge port, to minimize damage to the filter pack and/or the bentonite pellet seal, during grout placement. All grouts shall be prepared in accordance with the manufacturer's specifications. Bentonite grouts shall have a minimum density of 9.4 lbs/gal to ensure proper set-up. Cement grouts shall be mixed using 6.5 to 7 gallons of water per 94-

lb bag of portland cement (Type I). The addition of bentonite (5-to-10 percent) to the cement grout is for elasticity and the reason for its use shall be documented. The specific mixtures and other types of cements and/or grouts shall be evaluated on a case by case basis.

A.3.6 Above Ground Riser Pipe And Outer Protective Casing

The well casing, when installed and grouted, shall extend above the ground surface a minimum of 2.5 feet. In high traffic areas, the well casing may be located below grade, with a water proof cover. A vent hole shall be drilled or cut into the top of the well casing cap to permit pressure equalization, if applicable. An outer protective casing shall be installed into the borehole after the annular grout has "set" for at least 24 hours. The outer protective casing shall be of steel construction with a hinged, locking cap. Generally, an outer protective casing used over a 2-inch well casing is 4 inches square by 5 feet long. Similarly, a protective casing used over 4-inch well casings is 6 inches square and 5 feet long. Round protective casings are also acceptable. A protective casing shall have sufficient clearance around the inner well casing, so that the outer protective casing will not come into contact with the inner well casing after installation. The protective casing shall have a minimum of two weep holes for drainage. These weep holes shall be a minimum 1/4 inch in diameter and drilled into the protective casing just above the top of the level of concrete inside the protective casing to prevent water from standing inside of the protective casing. A protective casing made of aluminum or other soft metals is not acceptable because it is not strong enough to resist tampering. The protective casing is installed by pouring concrete into the borehole on top of the grout. The protective casing is then pushed into the wet concrete and borehole a minimum of 2 feet. Extra concrete may be needed to fill the inside of the protective casing so that the level of the concrete inside of the protective casing is at or above the level of the surface pad. The protective casings shall extend a minimum of 3 feet above the ground surface or to a height so that the cap of the inner well casing is exposed when the protective casing is opened.

A.3.7 Concrete Surface Pad

A concrete surface pad shall be installed around each well at the same time as the outer protective casing is being installed. The surface pad shall be formed around the well casing. Concrete shall be placed into the formed pad and into the borehole (on top of the grout) in one operation making a contiguous unit. The protective casing is then installed into the concrete as described in the previous section. The size of the concrete surface pad is dependent on the well casing size. The finished pad shall be sloped so that drainage will flow away from the protective casing and off of the pad. In addition, a minimum of one inch of the finished pad shall be below grade or ground elevation to prevent washing and undermining by soil erosion. All locks on the outer protective casings shall be keyed alike.

A.4 CONSTRUCTION TECHNIQUES

A.4.1 Well Installation

The borehole shall be bored, drilled, or augered as close to vertical as possible. Slanted

boreholes will not be acceptable unless specified in the design. The depth and volume of the borehole, including the overdrilling if applicable, shall have been calculated and the appropriate materials procured prior to drilling activities. The well casings shall be secured to the well screen by flush-jointed threads and placed into the borehole.

No lubricating oils or grease shall be used on casing threads. Teflon tape can be used to wrap the threads to insure a tight fit and minimize leakage. No glue of any type shall be used to secure casing joints. Teflon® "O" rings can also be used to insure a tight fit and minimize leakage; however, "O" rings made of other materials are not acceptable if the well is going to be sampled for organic compounds.

Before the well screen and casings are placed on the bottom of the borehole, at least 6 inches of filter material shall be placed at the bottom of the borehole to serve as a firm footing. The string of well screen and casing shall then be placed into the borehole and plumbed. Centralizers can be used to plumb a well, but centralizers shall be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Centralizers placed in the wrong places can cause bridging during material placement. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal. The specific placement intervals shall be decided based on site conditions. When installing the well screen and casings through hollow-stem augers, the augers shall be slowly extracted as the sand pack, bentonite seal, and grout are tremied and/or poured into place. The extraction of the augers will allow the materials, being placed through the augers, to flow into the borehole instead of flowing up into the bottom of the augers causing potential bridging problems. After the string of well screen and casing is plumb, the filter material shall then be placed around the well screen (preferably by the tremie method) up to the designated depth. After the filter pack has been installed, the bentonite pellet seal shall be placed (preferably by the tremie method) directly on top of the filter pack up to the designated depth or a minimum of 2 feet above the filter pack. The grout shall then be pumped by the tremie method into the annular space around the casings up to within 2 feet of the ground surface or below the frostline, whichever is greater. The grout shall be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed. After the surface pad and protective casing are installed, bumper guards shall be installed (if needed). The bumper guards (a minimum of 3 bumper guards per well) shall be placed around or incorporated into the concrete surface pad in a configuration that provides maximum protection to the well.

After the wells have been installed, the outer protective casing shall be painted with a highly visible enamel paint. Care must be taken not to introduce any paint into the well. The wells shall be permanently marked with the well number either on the cover or an appropriate place that will not be easily damaged and/or vandalized.

If the monitoring wells are installed in a high traffic area such as a parking lot, in a residential yard, or along the side of a road it might be desirable to complete the wells flush with the ground surface and install water-tight traffic covers. Traffic covers are designed to extend from the ground surface down into the concrete plug around the well casing. The covers shall have seals that make the unit water-tight when closed and secured. The traffic covers shall be installed as far above grade as practical to minimize standing water and promote runoff.

A.4.2 Double Cased Wells

Double cased wells shall be constructed when there is reason to believe that interconnection of two aquifers by well construction may cause cross contamination, and/or when flowing sands make it impossible to install a monitoring well using conventional methods. A pilot borehole shall be bored through the overburden and/or the contaminated zone into the clay confining layer or bedrock. An outer casing (sometimes called surface or pilot casings) shall then be placed into the borehole and sealed with grout. The borehole and outer casing shall extend into tight clay a minimum of five feet and into competent bedrock a minimum of two feet. The total depths into the clay or bedrock will vary, depending on the plasticity of the clay and the extent of weathering and/or fracturing of the bedrock. The size of the outer casing shall be of sufficient inside diameter (ID) to contain the inner casing, and the 2-inch minimum annular space. In addition, the borehole shall be of sufficient size to contain the outer casing and the 2-inch minimum outer annular space, if applicable. The outer casing shall be grouted by either the tremie method or by pressure grouting to within 2 feet of the ground surface. The grout shall be pumped into the annular space between the outer casing and the borehole wall. This can be accomplished by either placing the tremie tube in the annular space and pumping the grout from the bottom of the borehole to the surface, or placing a grout shoe or plug inside the casing at the bottom of the borehole and pumping the grout through the bottom grout plug and up the annular space on the outside of the casing. If the outer casing is set into very tight clay, both of the above methods might have to be used, because the clay usually forms a tight seal in the bottom and around the outside of the casing preventing grout from flowing freely during grout injection. On the other hand, outer casing set into bedrock normally will have space enough to allow grout to flow freely during injection. A minimum of 24 hours shall be allowed for the grout plug (seal) to "set" or cure before attempting to drill through it. The grout mixture used to seal the outer annular space can be either a neat cement, cement/bentonite, cement/sand, or a pure bentonite grout. However, the seal or plug at the bottom of the borehole and outer casing shall consist of a Type I portland cement/bentonite or cement/sand mixture. The use of a pure bentonite grout for a bottom plug or seal is not acceptable, because the bentonite grout sets or cures to a gel and is not rigid enough to withstand the stresses of drilling. When drilling through the seal, care shall be taken to avoid cracking, shattering, and/or washing out of the seal, which will be discussed in the next section. If caving conditions exist so that the outer casing cannot be sufficiently sealed by grouting, the outer casing shall be driven into place with a grout seal placed in the bottom of the casing. Removal of outer casings, which are sometimes called temporary surface casings, after well screens and casings have been installed and grouted is not acceptable. Trying to remove outer surface casings after the inner casings have been grouted could only jeopardize the structural integrity of the well.

A.4.3 Bedrock Wells

The installation of monitoring wells into bedrock can be accomplished in two ways:

1. The first method is to drill or bore a pilot borehole through the soil overburden into the bedrock. An outer casing is then installed into the borehole by setting it into the bedrock, and grouting it into place as described in the previous section. After the grout has set, the borehole can then be advanced through

the grout seal into the bedrock. The preferred method of advancing the borehole into the bedrock is rock coring. Rock coring makes a smooth, round hole through the seal and into the bedrock without cracking and/or shattering the seal. Roller cone bits are used in soft bedrock, but extreme caution shall be taken when using a roller cone bit to advance through the grout seal in the bottom of the borehole because excessive water and "down" pressure can cause cracking, eroding(washing), and/or shattering of the seal. Low volume air hammers have been used to advance the borehole, but they have a tendency to shatter the seal because of the hammering action. Any proposed method will be evaluated on its own merits, and will have to be approved by a senior staff geologist before drilling activities begin. When the drilling is complete, the finished well consists of an open borehole from the ground surface to the bottom of the well. There is no inner casing, and the outer surface casing, installed down into bedrock, extends above the ground surface, and also serves as the outer protective casing. If the protective casing becomes cracked or is sheared off at the ground surface, the well is open to direct contamination from the ground surface and will have to be repaired immediately or abandoned. In some instances, the outer surface casing is cut off at the surface or below the surface, depending on the design, and a separate outer protective casing is installed. Another limitation to the open rock well is that the entire bedrock interval serves as the monitoring zone. In this situation, it is very difficult or even impossible to monitor a specific zone, because the contaminants being monitored could be diluted to the extent of being nondetectable. The use of open bedrock wells are generally not acceptable in the RCRA programs because of the uncontrolled monitoring intervals. However, some site conditions might exist, especially in cavernous limestone areas (Karst topography) or in areas of highly fractured bedrock, where the installation of the filter pack and its structural integrity are questionable. Under these conditions the design of an open bedrock well may be warranted.

2. The second method of installing a monitoring well into bedrock is to install the outer surface casing and drill the borehole (by the approved method) into bedrock, and then install an inner casing and well screen with the filter pack, bentonite seal, and annular grout. The well is completed with a surface protective casing and concrete pad. This well installation method gives the flexibility of isolating the monitoring zone(s) and minimizing inter-aquifer flow. In addition, it gives structural integrity to the well, especially in unstable areas (steeply dipping shales, etc.) where the bedrock has a tendency to shift or move when disturbed. Omitting the filter pack around the well screen is a general practice in some open rock borehole installations, especially in drinking water and irrigation wells. However, without the filter pack to protect the screened interval, sediment particles from the well installation and/or from the monitoring zone could clog the well screen and/or fill the screened portion of the well rendering it inoperable. Also, the filter pack serves as a barrier between the bentonite seal and the screened interval. Rubber inflatable packers have been used to place the bentonite seal when the filter pack is omitted. This method is not acceptable because the packers have to remain in the well permanently

and, over a period of time, will decompose and possibly contribute contaminants to the monitoring zone.

A.5 WELL CONSTRUCTION MATERIALS

Well construction materials are chosen based on the goals and objectives of the proposed monitoring program and the geologic conditions at the site(s). In this section, the different types of available materials will be discussed.

A.5.1 Well Screen And Casing Materials

When selecting the materials for well construction, the prime concern shall be to select materials that will not contribute foreign constituents, either by leaching or sorption, into the monitoring zone and compromising the integrity of the well and future analytical data. Another concern is to select materials that will be rugged enough to endure the entire monitoring period. Site conditions will generally dictate the kind of materials that can be used. The best grade or highest quality material for that particular application should be selected. Each manufacturer can supply the qualitative data for each grade of material that is being considered. All materials selected for monitoring well installation shall be evaluated and approved by a senior staff geologist prior to field activities.

Well screen and casing materials generally used in monitoring well construction:

- (1) Teflon®
- (2) Rigid PVC
- (3) Stainless Steel (304 or 316)
- (4) Other (where applicable)

There are other materials used for well screens and casings such as black iron, carbon steel, galvanized steel, and fiberglass, but these materials are not recommended for use in long term monitoring programs on hazardous waste sites because of their low resistance to chemical attack and constituent distribution to the ground water.

In addition to material selection, the minimum diameter for well screens and casings used for permanent monitoring wells shall be 2 inches (inside diameter) (ID). The wall thickness has to be considered when selecting the 2-inch well screen and casing, because a 2-inch ID screen or casing having a total wall thickness greater than 1/8 inch will make the outside diameter (OD) 2 1/4 inches which will reduce the required 2-inch annular space. This is especially true for PVC and Teflon®. Schedule 5 stainless steel, which is commonly used for permanent monitoring wells has a very thin wall thickness (approximately 1/16 inch thick) which reduces the 2-inch annular space by only 1/8 inch. However, all minimum requirements for well design and installation shall be adhered to when selecting the appropriate materials. For example, if the ID of the screen or casing is 2 inches and the OD is 2 1/2 inches, then the borehole will have to be at least 6 1/2 inches in diameter to satisfy the minimum requirements.

The length of well screens in permanent monitoring wells should be long enough to effectively monitor the interval or zone of interest. However, well screens designed for long-term

monitoring purposes shall normally not be less than 5 feet in length. Well screens less than 5 feet long are routinely acceptable in temporary monitoring wells where ground water samples are collected for screening purposes only.

A.5.2 Filter Pack And Well Screen Design

The majority of monitoring wells that are installed at the facility are emplaced silts, clays, and sands in various combinations. Based upon the ubiquitous fine-grained materials in the shallow aquifer, the well screen size shall be 0.01 inches. The filter pack shall have the following characteristics:

- The well screen slot openings will retain 90 percent of the filter pack material.
- A filter material of varying grain sizes is not acceptable because the smaller particles fill the spaces between the larger particles thereby reducing the void spaces and increasing resistance to flow. Therefore, filter material of the same grain size and well rounded is preferred.
- The filter pack materials shall consist of clean, well-rounded-to-rounded, hard, insoluble particles of siliceous composition.

A.6 SAFETY PROCEDURES FOR DRILLING ACTIVITIES

The driller or designated safety person shall be responsible for the safety of the drilling team performing the drilling activities. All personnel conducting drilling activities shall be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, the area shall be surveyed with the necessary detection equipment to locate, flag or mark, all under ground utilities such as electrical lines, natural gas lines, fuel tanks and lines, water lines, etc. Before operating the drill rig, a pilot hole shall be dug (with hand equipment) to a depth of five feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements shall be adhered to while performing drilling activities:

- All drilling personnel shall wear safety hats, glasses, and steel toed boots. Ear plugs are required and shall be provided by the safety officer or driller.
- Work gloves (cotton, leather, etc.) shall be worn when working around or while handling drilling equipment.
- All personnel directly involved with the drilling rig shall know where the kill switches are located in case of emergencies.
- All personnel shall stay clear of the drill rods or augers while in motion, and shall not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating.

- Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.
- Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.
- Keep the drilling area clear of any excess debris, tools, or drilling equipment.
- Do not climb on the drilling rig while it is being operated or attempt to repair the rig while it is being operated. The driller shall direct the work on the rig.
- Do not move or pickup any drilling equipment unless directed by the driller and/or the project leader.
- Each drill rig shall have a first-aid kit, and fire extinguisher located on the rig quickly accessible for emergencies.
- Work clothes shall be firm fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.
- Rings or other jewelry shall not be worn while working around the drill rig.
- The drill rig shall not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig shall not be operated while there is lightning in the area of the drilling site. If an electrical storm moves in during drilling activities, vacate the area until it is safe to return.

A.7 WELL DEVELOPMENT

A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to "set" and cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to re-establish the natural hydraulic flow conditions of the formation, disturbed by well construction, around the immediate vicinity of the well. The new monitoring well shall be developed until the column of water in the well is free of visible sediment. Excessive or thick drilling muds can not be flushed out of a borehole with one or two well volumes of purge water. Continuous flushing for several hours may be necessary to complete the well development. If the well is pumped to near dryness or dryness, the water table shall be allowed to sufficiently recover before the next development period is initiated. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack. The onsite geologist shall make the decision as to the development completion of each well. All field decisions shall be documented in the field log book.

The following development procedures are generally used to develop monitoring wells:

- Pumping
- Compressed air (with the appropriate organic filter system)
- Bailing
- Surging
- Backwashing ("rawhiding")
- Jetting

The previous methods can be used, both individually and in combination, in order to achieve the most effective well development. The selected development method(s) shall be approved by a senior staff geologist before any well installation activities are initiated.

A.8 DRILLING LOG

A system of logging all pertinent data collected during drilling operations shall be maintained. The test hole locations should be recorded and referenced to the site map and/or datum base so that each location can be permanently established. It is imperative that drilling logs be concise, complete, and described in a manner that is easily understood to all who read them. The following items shall be included in the logging data:

- hole number and location;
- description of soils and subsurface conditions (if applicable);
- type of drilling equipment, driller, and drilling company (if applicable);
- method of drilling;
- type and size of casing;
- type and size of well screen;
- depth to well screen;
- drilling and sampling times;
- depth to water table, and date and time measured;

- type of samples taken and depths from which taken;
- volume of water purged;
- type of well (permanent or temporary);
- type of sampling equipment and/or cleaning procedure; and
- depth of sampling and description (if applicable).

A.9 WELL ABANDONMENT

When a decision is made to abandon a monitoring well, the borehole shall be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly abandon a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete.

A.9.1 Abandonment Procedures

The preferred method shall be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing shall then be removed from the hole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material shall be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). The top two feet of the borehole shall be poured with concrete to insure a secure surface seal (plug). If the area has heavy traffic use, and/or the well locations need to be permanently marked, then a protective surface pad(s) and/or steel bumper guards shall be installed. The concrete surface plug can also be recessed below ground surface if the potential for construction activities exists. This abandonment method can be accomplished on small diameter (one-inch to four-inch) wells without too much difficulty. With wells having six-inch or larger diameters, the use of hollow stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space and/or sound well casings can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case shall be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present. The tremie tube shall be retracted slowly as the grout fills the casing. The well casing shall be cut off even with the ground surface and filled with concrete to a depth of two feet below the surface. If the casing has been broken off below the surface, the grout shall be tremied to within two feet

of the surface and then finished to the ground surface with concrete. The surface pad or specified surface protection shall then be installed.

Well casings consisting of PVC material may be more difficult to remove from the borehole than metal casings, because of its brittleness. If the PVC well casing breaks during removal, the borehole shall be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by the selected drilling fluid. Another method is to use a solid-stem auger with a carbide auger head to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole shall be cleaned out and pressure grouted with the approved grouting materials. As previously stated, the borehole shall be finished with a concrete surface plug and adequate surface protection, unless directed otherwise.

APPENDIX B STANDARD CLEANING PROCEDURES

B.1 GENERAL

B.1.1 Introduction

The cleaning procedures outlined in this appendix are for use by field personnel in cleaning sampling and other field equipment as well as sample containers prior to field use. Sufficient clean equipment and sample containers should be transported to the field so that an entire sampling event can be conducted without the need for field cleaning of equipment. However, this will not always be possible when using specialized field equipment. Field cleaning procedures are included to cover these special areas. Emergency field sample container cleaning procedures are also included; however, they should not be used unless absolutely necessary. Specific cleaning procedures are presented in the following sections.

These procedures are the standard operating procedures (SOP) for the HOVIC facility. Deviations from these procedures must be documented in the field logbook.

B.1.2 Cleaning Materials

The cleaning materials referred to in this appendix are described in the following paragraphs.

The laboratory detergent shall be a standard brand of phosphate-free laboratory detergent such as Liquinox®. The use of any other detergent must be justified and documented in the field logbooks.

The nitric acid solution (10 percent) shall be made from reagent-grade nitric acid and deionized water.

The standard cleaning solvent shall be pesticide-grade isopropanol. However, other solvents may be substituted for a particular investigation if needed. Pesticide-grade acetone or methanol are both acceptable. However, it should be noted that if pesticide-grade acetone is used, the detection of acetone in samples collected with acetone rinsed equipment is suspect. Pesticide-grade methanol is much more hazardous to use than either pesticide-grade isopropanol or acetone, and its use is discouraged. Pesticide-grade hexane and petroleum ether are not miscible with water; therefore, these two solvents are not effective rinsing agents unless equipment is dry. The use of any solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified and its use must be documented in field logbooks and inspection or investigation reports.

Tap water may be used from any municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute for tap water.

Deionized water is defined as tap water that has been treated by passing through a standard deionizing resin column. Organic-free water is defined as tap water that has been treated with activated carbon and deionizing units.

During cleaning operations, the substitution of a higher grade water (i.e., deionized or organic-free water for tap water) is permitted and need not be noted as a variation of this SOP.

The solvents, nitric acid solution, laboratory detergent, and rinse waters used to clean equipment shall not be reused, except as specifically permitted in the footnote for Step 3, Appendix B.3.

B.1.3 Marking of Cleaned Sampling Equipment and Containers

All equipment and sample containers that are cleaned utilizing these procedures shall be tagged, labeled, or marked with the date that the equipment was cleaned. Also, if there was a deviation from the standard cleaning procedures outlined in this appendix, this fact should be noted on the label.

B.1.4 Marking and Segregation of Used Field Equipment

Field equipment or reusable sample containers needing cleaning or repairs will not be stored with clean equipment, sample tubing, or sample containers. All plastic wrapped equipment, containers and tubing not used in the field may be placed back in stock after the following precautions are taken:

- Soap and water rinse plastic containers. Allow to air dry.
- If plastic wrapping leaks after soap/water rinse, remove equipment and place into cleaning process.

B.1.5 Decontamination of Equipment Used to Collect Samples

Equipment that is used to collect samples shall be decontaminated before it is returned from the field. At a minimum, this decontamination procedure shall consist of washing with laboratory detergent and rinsing with tap water. More stringent decontamination procedures may be required, depending on the materials sampled.

B.1.6 Safety Procedures to be Utilized During Cleaning Operations

The materials used to implement the cleaning procedures outlined in this Appendix can be dangerous if improperly handled. Due caution must be exercised by all personnel and all applicable safety procedures shall be followed. At a minimum, the following precautions shall be taken in the washroom and in the field during these cleaning operations:

- Safety glasses with splash shields or goggles and neoprene gloves will be worn during all cleaning operations. When cleaning power augering or drill rig equipment, safety boots will be worn.
- All solvent rinsing operations will be conducted under a fume hood or in the open (never in a closed room).

- No eating, smoking, drinking, chewing, or any hand to mouth contact shall be permitted during cleaning operations.

B.2 SPECIFIC QUALITY CONTROL PROCEDURES FOR CLEANING OPERATIONS

B.2.1 General

This section establishes guidelines for specific quality control procedures to monitor the effectiveness of the sampling equipment and sample container cleaning procedures outlined in this appendix.

B.2.4 Sampling Equipment Cleaned in the Field

The effectiveness of field cleaning procedures shall be monitored by rinsing field cleaned equipment with organic-free water and submitting the rinse water in standard sample containers to the laboratory for analysis (equipment blank). Any time equipment is cleaned in the field, at least one such quality control sample shall be collected. No more than five percent of the equipment cleaned during sampling events shall be subjected to these procedures.

B.3 CLEANING PROCEDURES FOR TEFLON® OR GLASS FIELD SAMPLING EQUIPMENT USED FOR THE COLLECTION OF SAMPLES FOR TRACE ORGANIC COMPOUNDS AND/OR METALS ANALYSES*

1. Equipment will be washed thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.
2. The equipment will be rinsed thoroughly with tap water.
3. Rinse equipment with at least a 10 percent nitric acid solution.**
4. Rinse equipment thoroughly with tap water.
5. Rinse equipment thoroughly with deionized water.
6. Rinse equipment twice with solvent and allow to air dry.
7. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal.
8. Rinse the Teflon® or glass sampling equipment thoroughly with tap water in the field as soon as possible after use.

* - When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone or hexane to remove the materials before proceeding with Step 1. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the field equipment cannot be cleaned utilizing these procedures, it should be discarded.

** - Small and awkward equipment such as vacuum bottle inserts and well bailer may be soaked in the nitric acid solution instead of being rinsed with it. Fresh nitric acid solution should be prepared for each cleaning session.

B.4 CLEANING PROCEDURES FOR STAINLESS STEEL OR METAL SAMPLING EQUIPMENT USED FOR THE COLLECTION OF SAMPLES FOR TRACE ORGANIC COMPOUNDS AND/OR METALS ANALYSES*

1. Wash equipment thoroughly with laboratory detergent and water using a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment thoroughly with deionized water.
4. Rinse equipment twice with solvent and allow to air dry.
5. Rinse equipment with 10% HCl.
5. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.
6. Rinse the stainless steel or metal sampling equipment thoroughly with tap water in the field as soon as possible after use.

* - When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone or hexane to remove the materials before proceeding with Step 1. In extreme cases, when equipment is painted, badly rusted, or coated with materials that are difficult to remove, it may be necessary to steam clean, wire brush, or sandblast equipment before proceeding with Step 1. Any metal sampling equipment that cannot be cleaned using these procedures should be discarded.

** - Dilute hydrochloric acid should be used instead of nitric acid when cleaning stainless steel because nitric acid may potentially enhance the oxidization of the steel.

B.5 CLEANING PROCEDURES FOR SAMPLE TUBING

All Tubing shall be dedicated or disposable.

B.6 MISCELLANEOUS EQUIPMENT CLEANING PROCEDURES

B.6.1 Well Sounders or Tapes Used to Measure Ground Water Levels*

1. Wash with laboratory detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Allow to air dry overnight (doesn't apply to field cleaning).
5. Wrap equipment in aluminum foil.

B.6.2 Submersible Pumps and Hoses Used to Develop Ground Water Wells*

B.6.2.1 Centrifugal Pump Cleaning Procedure

CAUTION: To avoid damaging the pump never run pump when dry.

1. Pump a sufficient amount of soapy water through the hose to flush out any residual purge water.
2. Using a brush, scrub the exterior of the contaminated hose and pump with soapy water. Rinse the soap from the outside of the hose with tap water. Next rinse the hose with deionized water and recoil onto the spool.
3. Pump a sufficient amount of tap water through the hose to flush out soapy water.
4. Pump a sufficient amount of deionized water through the hose to flush out the tap water.
5. Rinse the outside of the pump housing and hose with deionized water (approximately 1/4 gal.).

* The same procedure applies whether this equipment is cleaned in the washroom or in the field.

B.6.2.2 Submersible Electric Pump Cleaning Procedure

CAUTION: During cleaning always disconnect the pump from the Generator.

1. Using a brush, scrub the exterior of the contaminated hose and pump with soapy water.
2. Rinse the soap from the outside of pump and hose with tap water.
3. Rinse the tap water residue from the outside of pump and hose with deionized water.

B.6.3 Portable Power Augers

1. The engine and power head should be cleaned with a power washer, steam jenny, or hand washed with a brush using detergent (does not have to be laboratory detergent but should not be a degreaser) to remove oil, grease, and hydraulic fluid from the exterior of the unit. These units should be rinsed thoroughly with tap water.
2. All auger flights and bits shall be cleaned utilizing the procedures outlined in Appendix B.4 (including footnotes) or Appendix B.8.3 (including footnotes if appropriate).

B.6.4 Large Soil Boring and Drilling Rigs

See Section B.7.3.

B.6.5 Miscellaneous Sampling and Flow Measuring Equipment

Miscellaneous flow measuring and sampling equipment shall be washed with laboratory detergent, rinsed with hot tap water, followed by a thorough deionized water rinse, and dried before being stored. This procedure is not used for any equipment utilized for the collection of samples for trace organic compounds or metals analyses.

B.6.6 Field Analytical Equipment and Other Field Instrumentation

The exterior of sealed, watertight equipment should be washed with a mild detergent (for example, liquid dishwashing detergent) and rinsed with tap water before storage. The interior of such equipment may be wiped with a damp cloth if necessary.

Other field instrumentation should be wiped with a clean, damp cloth; pH meter probes, conductivity probes, DO meter probes, etc., should be rinsed with deionized water before storage.

B.6.7 Ice Chests and Shipping Containers

All ice chests and reusable containers shall be washed with laboratory detergent (interior and exterior) and rinsed with tap water and air dried before storage. In the event that an ice chest becomes severely contaminated, in the opinion of the field investigator, with concentrated waste or other toxic material, it shall be cleaned as thoroughly as possible, rendered unusable, and properly disposed.

B.7 FIELD EQUIPMENT CLEANING PROCEDURES

B.7.1 General

Sufficient clean equipment should be transported to the field so that an entire study can be conducted without the need for field cleaning. However, this is not possible for some specialized items of field equipment such as portable power augers, well drilling rigs, soil coring rigs, and other large pieces of field equipment. In addition, particularly during large sampling events, it is not practical or possible to transport to the field all of the precleaned field equipment required. The following procedures are to be utilized when equipment must be cleaned in the field.

B.7.2 Teflon®, Glass, Stainless Steel or Metal Equipment Used to Collect Samples for Organic Compounds and Trace Metals Analyses*

1. Clean with tap water and laboratory detergent using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized water.
4. Rinse twice with solvent.
5. Rinse thoroughly with organic-free water and allow to air dry as long as possible.
6. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse with deionized or distilled water.
7. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported.

* - Portable power augers or large soil boring/drill rigs should be cleaned before boring or drilling operations. (See Appendices B.7.3 and B.7.4)

B.7.3 Cleaning of Lysimeter Sampling Equipment

Special consideration and attention to detail should be foremost when decontaminating the lysimeter sampling equipment. The size of the glass tubing, tubing port, and rubber stopper are difficult to clean and could collect residual material from previous sampling or cleaning. The following steps should be used when decontaminating all lysimeter sampling equipment:

- Rinse with deionized (DI) water;
- Completely disassemble lysimeter sample collection device;
- Wash using nonphosphate detergent;
- Rinse with DI water;
- Hexane or Isopropanol rinse and allow to air dry;
- Rinse with DI water; and,
- Allow to air dry.

The two way pump should not be cleaned in the above prescribed manner as it will adversely affect its operation. Instead, the pump should be cleaned as per the manufacturers recommendations. The connections at the base of the pump should be rinsed with deionized water in between sampling events.

APPENDIX C

SAFETY PROGRAM AND PROTOCOLS

C.1 GENERAL

C.1.1 Introduction

This Sampling and Analysis Plan has attempted to make safety protocols an intrinsic part of the procedures for each specific operation addressed. However, there are some protocols which were either not included in the other sections of this document or which merit more emphasis than given as part of normal operational procedures. It is the purpose of this appendix to address those protocols.

C.2 HAZARDOUS WASTE SAFETY PROTOCOLS

C.2.1 Equipment

Field employees will be provided with the following field clothing and safety equipment:

- Work gloves
- Safety glasses
- Goggles
- Hearing protection
- Hard hat
- Air purifying respirator

Under no circumstances will field personnel operate equipment for which they have not received training or have insufficient familiarity to conduct safe operations.

C.2.2 Training Status Tracking System

The facility and its contractors track the status of required safety training for all personnel involved in field operations within the facility. The system tracks the following safety training:

- Medical monitoring physicals (Annual renewal)
- HAZWOPPER training (No required renewal)
- 8-hour refresher training (Annual renewal)
- Cardio-pulmonary resuscitation (CPR) certification (Annual renewal)
- HOVIC site safety training (Annual renewal)

C.2.3 Specific Site Safety Plans

A site safety plan has been developed as part of the RFI investigations at the facility. Prior to commencing site activities, field personnel will be briefed on the contents of the safety plan. The plan's emergency instructions and directions will be posted in a conspicuous location at the Environmental building.

C.2.4 Site Operations

C.2.4.1 Initial Site Survey and Reconnaissance -- The purpose of an initial site survey/reconnaissance is to accomplish one or both of the following objectives:

- Determine the hazards that may exist which could affect site personnel.
- Verify existing information or obtain new information about the site.

To accomplish the first objective listed above, an assessment of the real or potential dangers from fire, explosion, and airborne contaminants must be made. This assessment will be made as follows:

- Organic Vapors and Gases -- The atmosphere will be monitored with a photoionization detector (PID) or a flame ionization detector (FID). Any response above background concentrations will cause an upgrade to level C respiratory protection.

C.2.4.2. Stress -- Field personnel on hazardous waste sites are exposed to both psychological and physiological stress. Psychological stress is countered with adequate training and job proficiency. Physiological stress is primarily due to exposure of the worker to extremes of heat.

- Heat Stress -- Heat stress can be the result of working during hot weather or wearing protective clothing that inhibits natural ventilation. It can occur even under moderate temperature condition. The following protocols are to be used to counter heat stress.

To allow workers to replace body fluids lost, water will be available at the site.

Field personnel are to be encouraged to maintain their physical fitness.

Intake of diuretics (coffee or alcohol) is to be minimized prior to field work.

- * All employees have been trained/medically monitored in accordance with OSHA 29 CFR 1910.12 requirements.

The following safety guides (1) should be observed whenever working around wastewater:

- Hands and fingers should be kept from the nose, mouth, eyes, and ears.
- Rubber gloves should be worn when handling wastewater, screening, sludge, or grit; or whenever handling equipment which has been in contact with untreated wastewater or sludge.
- Gloves should always be worn when hands are chapped or burned or when the skin is broken for any cause.
- Before eating and after work, the hands should be washed thoroughly with soap and hot water.
- All cuts and scratches should be given immediate first aid.

C.3.4.4 Safety Precautions at the Facilities -- The field staff will adhere to the safety rules maintained at the industry for protection of visitors and facility personnel. Safety procedures will be identified during the HOVIC Safety Training Course.

APPENDIX D

SHIPMENT OF ENVIRONMENTAL SAMPLES

Environmental samples shall be packed prior to shipment by air using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape. Line the cooler with a large heavy duty plastic bag.
2. Allow sufficient outage (ullage) in all bottles (except VOA's) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).
3. Be sure the lids on all bottles are tight (will not leak).
4. Place all bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape).
5. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or other packing material.
6. Line the bottom of the cooler with packing material.
7. Put "blue ice" (or ice that has been placed in heavy duty polyethylene bags and properly sealed) on top of or between the samples. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).
8. Measure the temperature of the temperature blank water. Ensure that the samples have been cooled to less than 4 degrees C prior sealing the cooler. Record the temperature in the field logbook and on the Chain-of-Custody record.
9. Place the Chain-of-Custody Record into a plastic bag, tape the bag to the inner side of the coolers lid, and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

CONTAINERS, HOLDING TIMES AND PRESERVATIVES

APPENDIX E

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR WATER AND WASTEWATER

GENERAL CHEMISTRIES

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Acidity	P,G	100	Cool, 4°C	14 days
Alkalinity	P,G	100	Cool, 4°C	14 days
BOD5 (Separate Bottle)	P,G	500	Cool, 4°C	48 hours
Bromide	P,G	200	Cool, 4°C	28 days
Carbonate	P,G	200	Cool, 4°C	14 days
Carbon Dioxide	P,G	200	Cool, 4°C	14 days
Chloride	P,G	50	Cool, 4°C	28 days
Chlorine Demand	P,G	100	None Required	A.I.
Chlorine Residual	P,G	200	None Required	A.I.
COD	P,G	50	H2SO4 < 2, Cool 4°C	28 days
Color	P,G	100	Cool, 4°C	48 hours
Conductance, Specific	P,G	100	Cool, 4°C	28 days
Corrosivity, Langlier Index*	P,G	500	Cool, 4°C	7 days
Cyanide	P	1000	NaOH > 12, Cool 4°C Ascorbic Acid	14 days
Cyanide, Amenable	P	2 x 1000	NaOH > 12	14 days
Fluoride	P	100	Cool, 4°C	28 days
Hardness	P,G	100	HN03 < 2, H2SO4 < 2	6 months
H2S (2 separate containers)*	P,G	300	NaOH, Zn Acetate	7 days
	P,G	100	Cool, 4°C	7 days
Ignitability	P,G	150	None Required	Not Specified
Iodide	P,G	200	Cool, 4°C	28 days
Nitrogen, Ammonia	P,G	200	H2SO4 < 2, Cool, 4°C	28 days

* Sample temperature Deg. C taken at Site

P - Plastic

G - Glass

A.I. - Analyze Immediately

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR WATER AND WASTEWATER

GENERAL CHEMISTRIES

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Nitrogen, TKN	P,G	50	H ₂ SO ₄ <2, Cool, 4°C	28 days
Nitrogen, Organic	P,G	50	H ₂ SO ₄ <2, Cool, 4°C	28 days
Nitrogen, Total	P,G	100	H ₂ SO ₄ <2, Cool, 4°C	28 days
Nitrogen, NO ₃ + NO ₂	P,G	50	H ₂ SO ₄ <2, Cool, 4°C	28 days
Nitrogen, Nitrite	P,G	200	Cool, 4°C	48 hours
Nitrogen, Nitrate (NO ₃)	P,G	250	Cool, 4°C	48 hours
Odor	G	400	None Required	A.I.
Oil & Grease	G, Teflon (cap)	2 x 1000	HCL <2, Cool, 4°C	28 days
Oxygen, Dissolved	G	300	None Required	A.I.
Petroleum Hydrocarbons	G, Teflon (cap)	2 x 1000	HCL <2, Cool, 4°C	7 days
pH	P,G	50	None Required	A.I.
Phenols	G, Teflon (cap)	200	H ₂ SO ₄ <2, Cool, 4°C	28 days
Phosphate, Ortho	P,G	200	F.O.S., Cool, 4°C	48 hours
Phosphorus, Total	P,G	200	H ₂ SO ₄ <2, Cool, 4°C	28 days
Silica, Dissolved	P	100	Cool, 4°C	28 days
Solids, Dissolved (TDS)	P,G	100	Cool, 4°C	7 days
Solids, Settleable	P,G	1000	Cool, 4°C	48 hours
Solids, Suspended (TSS)	P,G	100	Cool, 4°C	7 days
Solids, Total	P,G	100	Cool, 4°C	7 days
Solids, Volatile	P,G	100	Cool, 4°C	7 days
Sulfate	P,G	200	Cool, 4°C	28 days

P - Plastic
 G - Glass
 F.O.S. - Filter On Site
 A.I. - Analyze Immediately
 Z.H.S. - Zero Headspace

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR WATER AND WASTEWATER

GENERAL CHEMISTRIES

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Sulfide	P,G	200	NaOH, Zn Acetate Cool, 4°C	7 days
Sulfite	P,G	100	None Required	A.I.
Surfactants, MBAS	P,G	250	Cool, 4°C	48 hours
Total Organic Carbon	P,G	50	H ₂ SO ₄ <2, Cool, 4°C	28 days
Total Organic Halides	G, Teflon (cap)	300	H ₂ SO ₄ <2, Cool, 4°C ZHS	7 days
Turbidity	P,G	100	Cool, 4°C	48 hours

METALS AND MINERALS

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Hexavalent Chromium	P	300	Cool, 4°C	24 hours
All Metals	P	500	HN03 <2, Cool, 4°C	6 months (Hg 28 days)

MICROBIOLOGICAL

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Total Coliform	P,G Sterile	125**	Na ₂ S ₂ O ₃ , Cool, 4°C	6 hours
Fecal Coliform	P,G Sterile	125**	Na ₂ S ₂ O ₃ , Cool, 4°C	6 hours
Fecal Strep	P,G Sterile	125**	Na ₂ S ₂ O ₃ , Cool, 4°C	6 hours
Total Plate Count	P,G Sterile	125**	Na ₂ S ₂ O ₃ , Cool, 4°C	6 hours
Other	P,G Sterile	125**	Na ₂ S ₂ O ₃ , Cool, 4°C	6 hours

** Allow Headspace

P - Plastic
G - Glass

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR WATER AND WASTEWATER

ORGANIC TESTS (GC AND GC/MS)

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Volatiles (GC/MS)	G,Teflon Septum	3 x 40ml	HCL <2, Cool, 4°C	14 days
Volatiles (GC/VBTEX)	G,Teflon Septum	3 x 40ml	HCL <2, Cool, 4°C	14 days
Volatiles (GC 502,601,602)*	G,Teflon Septum	3 x 40ml	HCL <2, Cool, 4°C	14 days
Trihalomethanes	G,Teflon Septum	2 x 40ml	Ascorbic Acid/HCL Cool, 4°C	14 days
TPH Volatiles by GC	G,Teflon Septum	2 x 40ml	HCL <2, Cool, 4°C	14 days
Base Neutrals**	G,Teflon Cap	2/1000	Cool, 4°C	7 days extraction 40 analysis
Acid Extractable**	G,Teflon Cap	2/1000	Cool, 4°C	7 days extraction 40 analysis
Pesticides/PCB's	G,Teflon Cap	2/1000	Cool, 4°C	7 days extraction 40 analysis
TPH Semi-Volatile by GC	G,Teflon Cap	2/100	Cool, 4°C	7 days extraction 40 analysis
Pesticides/Herbicides	G,Teflon Cap	2/1000	Cool, 4°C	7 days extraction 40 analysis

* Add ascorbic acid if sample is chlorinated.

** Only 3 Liters needed for ABN combined analysis.

PRIORITY POLLUTANT PACKAGE

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Volatiles	G,Teflon Septum	3 x 40ml	Cool, 4°C	7 days
Acid/Base Neutrals	G,Teflon Cap	3x1000	Cool, 4°C	7 days extraction 40 analysis
Pesticides/PCB's	G,Teflon Cap	2/1000	Cool, 4°C	7 days extraction 40 analysis
Metals	P	500	HN03 <2, Cool, 4°C	6 months (Hg 28 days)
Cyanide	P	1000	Ascorbic Acid NaOH > 12, Cool, 4°C	14 days
Phenols	G	200	H2SO4 <2, Cool, 4°C	28 days

P - Plastic G - Glass

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR SOIL

ORGANIC TESTS (GC AND GC/MS)

PARAMETER	CONTAINER	VOLUME(ML)*	PRESERVATIVE	HOLDING TIME
Volatiles	G,Teflon	2 x 60ml	Cool, 4°C	14 days
TPH Volatiles by GC	G,Teflon	2 x 60ml	Cool, 4°C	14 days
All Other Analyses	G,Teflon Cap	300	Cool, 4°C	Contact Lab

PRIORITY POLLUTANT PACKAGE

PARAMETER	CONTAINER	VOLUME(ML)*	PRESERVATIVE	HOLDING TIME
Volatiles	G,Teflon Septum	2 x 60ml	Cool, 4°C	14 days
Acid Extractables/Base Neutrals/ Pesticides/PCB's/Metals/ Cyanide/Phenols	G,Teflon Cap	500	Cool, 4°C	14 days extraction 40 analysis. See water HT for metals, cyanide, phenols.

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR WATER AND SOIL

TOXIC CHARACTERISTIC LEACHATE PROCEDURE (TCLP)

Soils and Dry Sludges (> 50% solids)

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
TCLP Volatile Organics	G, Teflon	2 x 60 ml	Cool, 4°C	14 days leach, 14 days analysis
TCLP Acid Extractables/ Base Neutrals/Metals	G, Teflon	1 x 500ml for 1 or any combo of these parameters	Cool, 4°C	BN/A: 14 day leach, 7 days extraction 40 days analysis Metals(except Hg): 6 mos, Hg 28 days Leach 6 months, Hg 28 days analysis

P - Plastic
G - Glass

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR WATER AND SOIL

TOXIC CHARACTERISTIC LEACHATE PROCEDURE (TCLP)

Soils and Dry Sludges (> 50% solids)

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
TCLP Pesticides/Herbicides	G, Teflon	1 x 500ml for 1 or any combo of these parameters	Cool, 4°C	14 days leach, 7 days extraction 40 days analysis
TCLP Cyanide, Fluoride	G, Teflon	1 x 500ml for 1 or any combo of of these parameters	Cool, 4°C	14 days leach, 14 days analysis
PCB's (on intact sample)	G, Teflon	1 x 300ml	Cool, 4°C	7 days extraction, 40 days analysis
Ignitability, Sulfide/ Cyanide Reactivity (on intact sample)	G, Teflon	1 x 300ml for 1 or any combo of of these parameters	Cool, 4°C	14 days analysis

Waters and Wet Sludges (< 50% solids)

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
TCLP Volatile Organics	G, Teflon	3 x 40ml	Cool, 4°C	14 days leach, 14 days analysis
TCLP Acid Extractables	G, Teflon	3 x 1000 ml	Cool, 4°C	14 days leach, 7 days extraction 40 days analysis
TCLP Base Neutral Extractables	G, Teflon	3 x 1000 ml	Cool, 4°C	14 days leach, 7 days extraction 40 days analysis
TCLP Metals	G, Teflon	2 x 1000 ml	Cool, 4°C	Metals(except Hg): 6 mos, Hg 28 days Leach 6 mos, Hg 28 days analysis
TCLP Pesticides/Herbicides	G, Teflon	3 x 1000 ml	Cool, 4°C	14 days leach, 7 days extraction 40 days analysis
TCLP Cyanide, Fluoride	G, Teflon	2 x 1000 ml for 1 or any combo of these parameters	Cool, 4°C	14 days leach, 14 days analysis
PCB's (on intact sample)	G, Teflon	2 x 1000 ml	Cool, 4°C	7 days extraction, 40 days analysis

SAMPLE CONTAINERS, VOLUMES, PRESERVATION AND HOLDING TIMES FOR WATER AND SOIL

TOXIC CHARACTERISTIC LEACHATE PROCEDURE (TCLP)

Waters and Wet Sludges (< 50% solids)

PARAMETER	CONTAINER	VOLUME(ML)	PRESERVATIVE	HOLDING TIME
Ignitability, Sulfide/ Cyanide Reactivity (on intact sample)	G, Teflon	1 x 300ml for 1 or any combo of of these parameters	Cool, 4°C	14 days analysis

PRESERVATIVE INSTRUCTIONS

IDENTIFICATION:

RED	Nitric Acid (HN03)	1 to 1 Concentration
YELLOW	Sulfuric Acid (H2S04)	1 to 1 Concentration
BLUE	Ascorbic Acid/NaOH	10 N Concentration
GREEN	Hydrochloric Acid (HCL)	1 to 1 Concentration

- 1) All preservatives are supplied in borosilicate glass vials with teflon caps.
CAUTION: Preservatives are extremely corrosive and should be handled by experienced field personnel only!
- 2) After the water sample has been collected, add the complete contents of the appropriate preservative vial to the sample. Cap container tightly and label.
- 3) Keep all samples on ice, in coolers, at 4°C, during sampling and transport to the laboratory.

Contact the Laboratory for Containers, Preservatives, Trip Blanks, Field Blanks, Coolers, Labels and Chain of Custody Forms.

APPENDIX F

ANALYTICAL PARAMETERS AND PROCEDURES

GROUNDWATER

FACILITY	CONSTITUENT	UNITS	MDL	METHODS(1)
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LANDFARM 1

Volatiles

Benzene	ug/L	5	8240
Carbon Disulfide	ug/L	5	8240
Chlorobenzene	ug/L	5	8240
Chloroform	ug/L	5	8240
1,2-Dichloroethane	ug/L	5	8240
1,4-Dioxane	ug/L	150	8015
Ethylbenzene	ug/L	5	8240
Ethylene dibromide	ug/L	5	8240
Methyl ethyl ketone	ug/L	10	8015
Styrene	ug/L	5	8240
Toluene	ug/L	5	8240
m-Xylene	ug/L	10	8240
o + p-Xylenes	ug/L	10	8240

Semivolatile Acid-Extractable Compounds

Benzenethiol	ug/L	20	8270
m + p-Cresols	ug/L	10	8270
o-Cresols	ug/L	10	8270
2,4 Dimethylphenol	ug/L	10	8270
2,4-Dinitrophenol	ug/L	50	8270
4-Nitrophenol	ug/L	50	8270
Phenol	ug/L	10	8270

Semivolatile Base/Neutral-Extractable Compounds

Anthracene	ug/L	10	8270
Benzo(a)anthracene	ug/L	10	8270
Benzo(b)fluoranthene	ug/L	10	8270
Benzo(k)fluoranthene	ug/L	10	8270
Benzo(a)pyrene	ug/L	10	8270
Bis(2-ethylhexyl)phthalate	ug/L	10	8270
Butyl benzyl phthalate	ug/L	10	8270
Chrysene	ug/L	10	8270
Dibenz[a,h]acridine	ug/L	10	8270
Dibenz[a,h]anthracene	ug/L	10	8270
1,2-Dichlorobenzene	ug/L	10	8270

GROUNDWATER

FACILITY	CONSTITUENT	UNITS	MDL	METHODS(1)
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LANDFARM 1				
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<u>Semivolatile Base/Neutral-Extractable Compounds</u>
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1,3-Dichlorobenzene	ug/L	10	8270
1,4-Dichlorobenzene	ug/L	10	8270
Diethyl phthalate	ug/L	10	8270
7,12-Dimethylbenz(a)anthracene	ug/L	10	8270
Diethyl phthalate	ug/L	10	8270
Di-n-butylphthalate	ug/L	10	8270
Di-n-octylphthalate	ug/L	10	8270
Fluoranthene	ug/L	10	8270
Indene	ug/L	10	8270
Methyl chrysene	ug/L	10	8270
1-Methyl naphthalene	ug/L	10	8270
Naphthalene	ug/L	10	8270
Phenanthrene	ug/L	10	8270
Pyrene	ug/L	10	8270
Pyridine	ug/L	10	8270
Quinoline	ug/L	10	8270

<u>Metals (Total)</u>

Antimony	ug/L	300	6010
Arsenic	ug/L	10	7060
Barium	ug/L	20	6010
Beryllium	ug/L	3	6010
Cadmium	ug/L	40	6010
Chromium	ug/L	10	7191
Cobalt	ug/L	70	6010
Lead	ug/L	10	7421
Mercury	ug/L	2	7470
Nickel	ug/L	50	6010
Selenium	ug/L	20	7740
Vanadium	ug/L	80	6010

GROUNDWATER

FACILITY	CONSTITUENT	UNITS	MDL	METHODS(1)
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GROUPS 1, 2, & 3

Volatiles

Benzene	ug/L	5	8240
Toluene	ug/L	5	8240
Xylenes(total)	ug/L	10	8240

Semivolatile Acid-Extractable Compounds

2,4 Dimethylphenol	ug/L	10	8270
Phenolics	ug/L	100	420.1,2

Metals (Total)

Chromium	ug/L	10	7191
Lead	ug/L	10	7421
Selenium	ug/L	20	7740
Vanadium	ug/L	80	6010

SOIL CORES

LANDFARMS 2 & 3

Barium	ug/kg	2000	6010
Chromium	ug/kg	200	7191
Lead	ug/kg	500	7420
Vanadium	ug/kg	2000	6010
Benzo(a)pyrene	ug/kg	250	8270
2,4-Dimethylphenol	ug/kg	270	8270
Naphthalene	ug/kg	160	8270
Phenol	ug/kg	150	8270

SOIL-PORE LIQUID

FACILITY	CONSTITUENT	UNITS	MDL	METHODS(1)
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LANDFARMS 2 & 3

Chromium	ug/L	10	7191
Lead	ug/L	10	7421
Vanadium	ug/L	80	6010
Benzene	ug/L	5	8240
2,4-Dimethylphenol	ug/L	10	8270
Phenol	ug/L	10	8270
Toluene	ug/L	5	8240

(1) From SW-846

APPENDIX G

OPERATION OF BLADDER PUMPS

G.1 General

The facility has several bladder pumps and purge pumps (no bladder) which can be used for purging monitoring wells. The bladder pumps, when used near the top of the water column, have a very low efficiency and will generally not purge more than 0.5 gallons per minute. The purge pump, however, can achieve pump rates of up to two gallons per minute in these situations. The efficiency of the bladder pumps is restricted by the rigid Teflon® bladder, which requires significant hydrostatic head for rapid and complete filling. The purge pump, having no bladder, fills much faster under the same conditions.

Both pumps operate by cycling a pressurized gas on and off in a discharge and refill cycle. The gas, atmospheric air or nitrogen, is pressurized and regulated by a compressor/regulator combination (controller). Air is supplied by a portable compressor. Nitrogen is supplied by compressed gas cylinders.

G.2 Operation - Bladder Pump

1. Connect air supply hose to "pump supply" connection on controller and to brass air connection on compressor or nitrogen cylinder.
2. Lower pump into well and place the intake of the pump three feet below the top of the water column.
3. Turn on the compressor. If the gasoline powered compressor is used, place it as far from the well as possible, in the down wind direction.
4. Adjust the timing of the discharge and refill cycles until a flow rate of 0.3 L/min. is achieved.

G.3 Operation - Purge Pump (for well development)

1. Connect air supply hose to "pump supply" connection on controller and connection on top of pump. Observe flow direction arrow on purge pump exhaust adapter. The arrow must point in the direction of air flow from the controller to the pump.
2. Attach adequate length of tubing to hose fitting at top of pump.
3. Lower pump, air hose and discharge tubing into water column until the top of the pump is several feet below the top of the water column.

4. Turn on the compressor. If the gasoline powered compressor is used, place it as far from the well as possible, in the down wind direction.
5. Adjust the timing of the discharge and refill cycles until maximum flow is achieved.
6. Lower the pump, as necessary, if the water level is reduced in the well.

G.4 Trouble Shooting

Compressor running, no pressure on discharge cycle

1. Air supply fittings loose

1. Check all fittings and tighten

2. Bladder is perforated

2. Replace bladder

3. Exhaust adapter installed in wrong direction

3. Remove adapter and replace in correct orientation

Compressor running, pressure low, no water discharged

1. Obstruction in ball check assembly allowing water to be pushed out of pump at check

1. Remove obstruction

2. Air supply fittings loose

2. Check all fittings

APPENDIX H

USE AND CALIBRATION OF FIELD ANALYTICAL EQUIPMENT

METHOD H.1 TEMPERATURE

H.1.1 Summary of Method

Temperature measurements may be made with any high quality mercury-filled thermometer or thermistor with analog or digital read-out devices.

H.1.2 Test Procedure

2. Allow thermometer or thermistor enough time to equilibrate to outside temperature when removed from a field vehicle.
3. Insert thermometer into the sample. Swirl the thermometer or thermistor in the sample and take the temperature reading when the mercury column or read-out indicator stops moving; record temperature to the nearest 0.5°C.

H.1.3 Precision and Accuracy

Precision and accuracy for this method have not been determined.

METHOD H.2 pH (HYDROGEN ION CONCENTRATION)

H.2.1 Summary of Method

The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode, and a pH meter.

H.2.2 Interferences

1. The glass electrode, in general, is not subject to solution interferences from color, turbidity, colloidal matter, oxidants, reductants, or high salinity.
2. Coatings of oily material or particulate matter can impair electrode response. Remove these coatings by gentle wiping with a laboratory tissue followed by a distilled water rinse.
3. Temperature effects on the electrometric measurement of pH are controlled by using instruments having temperature compensation or by calibrating the electrode meter system at the temperature of the samples.

4. Poorly buffered solutions with low specific conductance values (less than 200 μmhos) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several portions of sample before taking pH measurement.

H.2.3 Reagents

Secondary standard buffer solutions (pH 4, pH 7, and pH 10) purchased from commercial vendors shall be used.

H.2.4 Calibration

1. Follow the instructions provided with each type of pH meter.
2. Each meter/electrode system must be buffered at a minimum of two points which bracket the expected pH of the samples. The buffer solutions should be approximately three pH units or more apart.

H.2.5 Test Procedure

1. Allow the meter to equilibrate to ambient temperature when it is removed from a field vehicle.
2. Calibrate the meter as outlined above in Appendix H.2.4.
3. Thoroughly rinse the electrode with distilled water.
4. Immerse the electrode in a flow cell, if possible, or in a grab sample. Swirl the electrode at a constant rate until the meter reading reaches equilibrium. The rate of stirring used should minimize the air transfer rate at the air-water interface of the sample.
5. Note and record sample pH; repeat measurement on successive volumes of sample or in the flow cell until values differ by no more than 0.1 pH unit. Two or three volumes are usually sufficient.
6. When the meter is moved to another sampling location, recheck the meter calibration by inserting the probe into the pH 7 buffer solution and follow operational steps outlined in the owners manual.

Note -- Follow the operating instructions for the specific meters.

H.2.6 Precision and Accuracy

Under normal conditions the accuracy is ± 0.1 pH unit.

METHOD H.3 DISSOLVED OXYGEN (MEMBRANE ELECTRODE)

H.3.1 Summary of Method

The most common ME instruments for determination of DO in water are dependent upon electrochemical reactions. Under steady-state conditions, the current or potential can be correlated with DO concentration. Interfacial dynamics at the ME-sample interface are a factor in probe response and a significant degree of interfacial turbulence is necessary. For precision performance, turbulence should be constant.

Refer to the manufacturer's instructions for calibrating and operating each specific DO meter.

H.3.2 Interferences

- Dissolved organic materials are not known to interfere in the output from DO probes.
- Dissolved inorganic salts are a factor in the performance of DO probes
- Reactive gases which pass through the ME probes may interfere. For example, chlorine will depolarize the cathode and cause a high probe output. Long-term exposures to chlorine will coat the anode with the chloride of the anode metal and eventually desensitize the probe. Hydrogen sulfide will interfere with ME probes if the applied potential is greater than the half-wave potential of the sulfide ion.
- Dissolved oxygen ME probes are temperature sensitive, and temperature compensation is normally provided by the manufacturer.

H.3.3 Calibration

1. Adjust the meter according to manufacturer's instructions.

H.3.4 Test Procedure

1. When making measurements be sure that the ME stirring apparatus is working, adjust the temperature compensator, and read the DO dial to the nearest 0.1 mg/l.
2. Keep the probe in water when not in use to prevent the membrane from drying out.
3. If the sample temperature is 5°C greater than the calibration temperature, the meter should be recalibrated to the temperature of the sample.

H.3.5 Precision and Accuracy

Manufacturer's specification claims 0.1 mg/l repeatability with \pm 1 percent accuracy.

METHOD H.4 SPECIFIC CONDUCTANCE

H.4.1 Summary of Method

- The specific conductance of a sample is measured by use of a self-contained conductivity meter, Whetstone bridge-type, or equivalent.
- Automatic temperature compensation corrections are made and results reported at 25°C.

H.4.2 Test Procedure

1. Follow instructions manual for specific field conductivity meter used.
2. Check the meter with two standard solutions of approximate specific conductances of 100 and 1,000 umhos/cm, or standards that bracket the expected sample conductance. If the meter does not read within one percent of the standards, determine what the problem is and correct it before proceeding. Most field instruments read conductivity directly; with those instruments, follow the manufacturer's instructions. Report the results to the nearest ten units for readings under 1,000 umhos/cm and the nearest 100 units for readings over 1,000 umhos/cm.

H.4.3 Precision and Accuracy

The conductivity meters have an accuracy of \pm 2 percent of reading. With satisfactory equipment, results within 1 percent of the true value should be obtained.

METHOD H.5 TURBIDITY

H.5.1 Summary of Method

The turbidity of a sample is determined by using light reflection or scatter. The reflected light is proportional to the amount of suspended particles in water.

H.5.2 Interferences

1. Coatings of oily material or particulate matter can impair photodetector response. Remove these coatings by gentle wiping with a laboratory tissue followed by a distilled water rinse.

H.5.3 Reagents

Standard calibration solutions purchased from commercial vendors shall be used.

H.5.4 Calibration

1. Follow the instructions provided with each type of turbidity meter.

H.5.5 Test Procedure

1. Allow the meter to equilibrate to ambient temperature when it is removed from a field vehicle.
2. Calibrate the meter as outlined above in Appendix H.5.4.
3. Thoroughly rinse the detector electrode with distilled water.
4. Immerse the electrode in a flow cell, if possible, or place a grab sample into a vial and insert the vial into the appropriate slot in the meter, depending on the type of meter.
5. Note and record sample turbidity; repeat measurement on successive volumes of sample or in the flow cell until values differ by no more than 10%. Two or three volumes are usually sufficient.

Note -- Follow the operating instructions for the specific meters.

H.2.6 Precision and Accuracy

Under normal conditions the accuracy is $\pm 3\%$.

METHOD H.6 OXIDATION REDUCTION POTENTIAL (ORP)

H.6.1 Summary of Method

The ORP of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode, and a pH-ORP meter.

H.6.2 Interferences

1. The glass electrode, in general, is not subject to solution interferences from color, turbidity, colloidal matter, oxidants, reductants, or high salinity.
2. Coatings of oily material or particulate matter can impair electrode response. Remove these coatings by gentle wiping with a laboratory tissue followed by a distilled water rinse.

3. Temperature effects on the electrometric measurement of ORP are controlled by using instruments having temperature compensation or by calibrating the electrode meter system at the temperature of the samples.

H.6.3 Reagents

None.

H.6.4 Calibration

1. Follow the instructions provided with each type of pH-ORP meter.

H.2.5 Test Procedure

1. Allow the meter to equilibrate to ambient temperature when it is removed from a field vehicle.
2. Calibrate the meter as outlined above in Appendix H.6.4.
3. Thoroughly rinse the electrode with distilled water.
4. Immerse the electrode in a flow cell possible or in a grab sample. Swirl the electrode at a constant rate until the meter reading reaches equilibrium. The rate of stirring used should minimize the air transfer rate at the air-water interface of the sample.
5. Note and record sample ORP; repeat measurement on successive volumes of sample or in the flow cell until values differ by no more than 10 millivolts. Two or three volumes are usually sufficient.

Note -- Follow the operating instructions for the specific meters.

H.2.6 Precision and Accuracy

Under normal conditions the accuracy is ± 0.2 millivolts.

APPENDIX I

SOIL SAMPLING EQUIPMENT AND PROCEDURES

I.1 General

The soil sampling procedures and equipment described below are presented as potential acceptable alternatives should the standard soil sampling equipment be unavailable. These methods are presented in comprehensive form so that they also may be applicable to other soil sampling events at the facility.

I.2 Sampling Methodology

This discussion of soil sampling methodology reflects both the equipment used (required/needed) to collect the sample, as well as how the sample is handled and processed after retrieval. Selection of equipment is usually based on the depth of samples, but it is also controlled, to a certain extent, by the characteristics of the material. Simple, manual techniques and equipment, such as hand augers, are usually selected for surface or shallow, subsurface soil sampling. As the depth of the sampling interval becomes greater, some type of powered sampling equipment is usually needed to overcome torque induced by soil resistance and depth. The following is an overview of the various sample collection methods employed over three general depth classifications: surface, shallow subsurface, and deep subsurface. Any of the deep collection methods described may be used to collect samples from the shallower intervals.

I.2.1 Manual (Hand Operated) Collection Techniques and Equipment

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. The shallow subsurface interval may be considered to extend from approximately 12 inches below ground surface to a site-specific depth at which sample collection using manual, i.e., hand-powered, methods becomes impractical.

I.2.2 Subsurface Soils -- Hand-augering is the most common manual method used to collect subsurface samples. Typically, 4-inch auger-buckets with cutting heads are pushed and twisted into the ground and removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand-auger is related to the material being sampled. In sands, augering is usually easily accomplished, but the depth of investigation is controlled by the depth at which sands begin to cave. At this point, auger holes usually begin to collapse and cannot practically be advanced to lower depths, and further samples, if required, must be collected using some type of pushed or driven device. Hand-augering may also become difficult in tight clays or cemented sands. At depths approaching 20 feet, torquing of hand-auger extensions becomes so severe that in resistant materials, powered methods must be used if deeper samples are required. Some powered methods, discussed later, are not acceptable for actual sample collection, but are used solely to gain easier access to the required sample depth, where hand-augers or push tubes are generally used to collect the sample.

When a vertical sampling interval has been established, one auger-bucket is used to advance the auger hole to the first desired sampling depth. If the sample at this location is to be a vertical composite of all intervals, the same bucket may be used to advance the hole, as well collect subsequent samples in the same hole. However, if discrete grab samples are to be collected to characterize each depth, a new or cleaned bucket must be placed on the end of the auger extension immediately prior to collecting the next sample. The top several inches of soil should be removed from the bucket to minimize the chances of cross-contamination of the sample from fall-in of material from the upper portions of the hole.

Another hand-operated piece of soil sampling equipment commonly used to collect shallow subsurface soil samples is the Shelby or "push tube". This is simply a thin-walled tube, generally of stainless steel construction and having a beveled leading edge, which is twisted and pushed directly into the soil. This type of sampling device is particularly useful if a relatively undisturbed sample is required. The sampling device is removed from the push-head, then the sample is extruded from the tube into the pan with a spoon or special extruder. Even though the push-head is equipped with a check valve to help retain samples, the Shelby tube will generally not retain loose and watery soils, particularly if collected at lower depths.

1.2.3 Powered Sampling Devices

Powered sampling devices and sampling aids may be used to acquire samples from any depth but they are generally limited to depths of 20 feet or less. Among the common types of powered equipment used to collect or aid in the collection of subsurface soil samples are Little Beaver®-type two-man power augers; split-spoon samplers driven with a drill rig drive-weight assembly or hydraulically pushed using drill rig hydraulics; continuous split-spoon samplers; specialized hydraulic cone penetrometer rigs; and back-hoes. The use of each of these is described below.

1.2.4 Power Augers

Two-man power augers of the Little Beaver® variety, are commonly used to aid in the collection of subsurface soil samples at depths where hand augering is impractical. This type of equipment is technically a sampling aid and not a sampling device, and 20 to 25 feet is the typical lower depth range for this equipment. It is used to advance a hole to the required sampling depth, at which point a hand auger is usually used to collect the sample.

1.2.5 Drill Rigs

Drill rigs offer the capability of collecting soil samples from greater depths. For all practical purposes, the depth of investigation achievable by this method is controlled only by the depth of soil overlying bedrock, which may be in excess of 100 feet.

When used in conjunction with drilling, split-spoon samplers are usually driven either inside a hollow-stem auger or inside an open borehole after rotary drilling equipment has been temporarily removed. The spoon is driven with a 140-pound hammer through a distance of up to 24 inches and removed. If geotechnical data are also required, the number of blows with the hammer for each six-inch interval is also recorded.

Continuous split-spoon samplers may be used to obtain five-foot long, continuous samples approximately 3 to 5 inches in diameter. These devices are located inside a five-foot section of hollow-stem auger and advanced with the auger during drilling. As the auger advances, the central core of soil moves into the sampler and is retained until retrieval.

1.2.6 Cone Penetrometer Rigs

This method involves the modification of a standard split-spoon. The spoon has been modified with a releasable tip which keeps the spoon closed during the sampling push. Upon arrival at the desired depth, the tip can be remotely released and the push continued. During the subsequent push, the released tip floats freely up the inside of the spoon as the soil core displaces it. Split-spoon soil samples, therefore, can be collected without drilling, as has historically been required, by simply pushing the device to the desired depth. This technique is particularly beneficial at highly contaminated sites, because cuttings are not produced as with drill rigs. The push rods are generally retrieved with very little residue. This results in minimal exposure to sampling personnel and very little contaminated residue is produced as a result of equipment cleaning.

1.2.7 Back-Hoes

Back-hoes are often utilized in shallow subsurface soil sampling programs. Samples may either be collected directly from the back-hoe bucket or they may be collected from the trench wall if proper safety protocols are followed. Trenches offer the ability to collect samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. Prior to collecting samples from trench walls, the wall surface must be dressed with a stainless steel shovel, spatula, knife, or spoon to remove the surface layer of soil which was smeared across the trench wall as the bucket passed. If back-hoe buckets are not cleaned according to the procedures described in Section B.8.3 of this manual, samples must be collected from material which has not been in contact with the bucket surface.

1.3 Special Techniques and Considerations

1.3.1 Collection of Soil Samples for Purgeable Organic Compound (VOA) Analyses

These samples should be collected in a manner that minimizes disturbance of the sample. For example, when sampling with a hand auger, the VOA sample may be collected directly from the auger bucket or immediately after an auger bucket is emptied into the pan. The sample should be placed in the appropriate container with no head-space, if possible, as is the practice with water samples. Samples for VOA analysis are not mixed.

1.3.2 Dressing Soil Surfaces

Any time a vertical or near vertical surface, such as is achieved when shovels or back-hoes are used for subsurface sampling, is sampled, the surface should be dressed to remove smeared soil. This is necessary to minimize the effects of cross-contamination due to smearing of material from other levels.

1.3.3 Sample Mixing

It is extremely important that soil samples be mixed as thoroughly as possible to ensure that the sample is representative of the interval sampled. Samples for VOA analysis are not mixed.

I.3.4 Special Precautions for Trace Contaminant Soil Sampling

The procedures outlined in Section 4 and 5 of the Sampling and Analysis Plan shall be followed. All soil sampling equipment used for sampling for trace contaminants should be constructed of stainless steel where possible. Pans used for mixing shall be made of Pyrex®, or equivalent, glass. In no case will chromium, cadmium, or galvanized plated or coated equipment be used for soil sampling operations. Similarly, no painted or plastic equipment shall be used. All paint and primer must be removed from soil sampling equipment by sandblasting or other means before such equipment can be used for collecting soil samples.

I.3.5 Specific Sampling Equipment Quality Assurance Techniques

Drilling rigs and other major equipment used to collect soil samples shall be identified so that this equipment can be traced through field records. Sampling spoons, hand augers, Shelby tubes, and other minor disposable type equipment are exempted from this equipment identification requirement.

- All equipment used to collect soil samples shall be cleaned as outlined in Appendix B and repaired, if necessary, before being stored at the conclusion of field studies.
- Any cleaning conducted in the field (Appendix B) or field repairs should be thoroughly documented in field records.

Samples should be accurately tagged and labeled with all pertinent site information at the time of sampling. See Section 4 for sample labeling and field recording procedures.